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THE USELESS PROBLEM GRIND

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RICE in 1893 published his researches on spelling under the title, *The Spelling Grind.*[1] It was a grind, without profit, because too many of the words were beyond the use-comprehension of the children who tried to spell the words. The pupils did poorly regardless of what was done to teach them, regardless, of method used, regardless of time taken for the recitation, regardless of teacher merit or supervision.

It took a long time to discover the reasons for this failure in spelling and the combined efforts of many men, — Cornman, Wallin, Ayres, Thorndike, Horn, Tidyman, and others. But when the answer was found it was a very simple one and impressed everyone with the common sense on which it rested. The chief item in the answer was, — *omit the meaningless words,* since evidently there is little profit in trying to learn to spell them. If a pupil does not know the meaning of a word, he will not use it and accordingly will not need to know how to spell it. In cutting the spelling load from 12,000 or 15,000 words to 1000, 2000, or 3000 (according to the intelligence of the child,) there was no loss. With 1000 most common words thoroughly mastered, one can spell 90% of the running words of adult correspondence.[2] Few eighth grade children have a writing vocabulary that reaches 3000 words. The excess of words over these limits is for all practical purposes useless, and should be omitted. The excuse that vocabulary may be taught is a very weak excuse (and is comparable to the excuse that meaningless written problems in Arithmetic will give valuable vicarious experience.)

In the study of written problems in Arithmetic we have passed the first stages in the investigation (comparable to the stage Rice had arrived at in 1893 in the study of spelling.) We know that when the energies of children are expended upon isolated written problems such as are common in textbooks, the results are poor regardless of what is done. Studies by Osburn,[3] Morton,[4] Clapp,[5] Brownell,[6]

1 Rice, J. M., "The Futility of the Spelling Grind," Forum 23: 163, 409.
2 Ayres, Leonard P., "Writing Vocabulary of Personal and Business Letters," Russell Sage Foundation, 1913.
3 Osburn, W. J., "Reading Difficulties in Arithmetic," Wisconsin Department of Education, 1925.
4 Morton, R. L., "Factors Affecting the Ability to Solve Verbal Problems in Arithmetic," Ohio State University, 1925.
5 Hydle, L. L., and Clapp, F. L., "Elements of Difficulty in the Interpretation of Concrete Problems in Arithmetic," University of Wisconsin Bureau of Educational Research,, Bulletin 9, 1927.
6 Brownell, W. A., and Stretch, L. B., "Effect of Unfamiliar Settings on Problem Solving," Duke University Press, 1931.

Stevens,[7] Kramer,[8] and others have proven that the work on the usual isolated written problems has little profit because the results are always poor and nothing makes any difference, or much difference. The form of the problem may be changed (see Kramer,) the problem may be made longer and more interesting (see Osburn,) the teacher or text determined situation may be changed even to senseless situations or very simple ones (see Brownell,) the reading ability of pupils may be increased (see Osburn,) the vocabulary may be made easier (see Kramer,) and as a result of any of these changes the improvement will be so small in most cases as not to cause a "significant" difference. That is, by and large, when the energy of the class and teacher are expended on isolated textbook types of written problems, the results are poor and nothing makes much if any difference.

There is accumulating evidence that a better way has been found, possibly the final solution. McMahon found that children could neglect the usual type of written problem work, devoting themselves to personalized community-adjusted problem units, without loss of skill as measured by the traditional problem scale.[9] This is a significant negative result. In fact McMahon's pupils did better than the control group who gave their time to the usual type of problem work.

Connor and Hawkins showed that when pupils at the junior high school level brought in their own problems, they showed a significant excess of gains over pupils who continued with text problems.[10] The teachers, however, resisted the extra effort and tended to drop back to reliance on the textbook. Probably in time a better type of text will appear.

Harap has shown that significant problem units are better for the mastery of unusual processes such as decimals or division of fractions.[11] His studies afford an interesting comment on the common and erroneous assumption that problems must be subordinated to processes. The more important conclusion from his studies is that if a situation is real and vital it has much greater teaching power.

Obviously a situation cannot be vital to a child if it relates to something which he knows nothing about. But there is more to it than that. An entirely new approach is being developed in functional problem units, based upon the justifiable purpose of such work.

What is the true purpose of problem work? The answer comes from life, not from the traditional school. In life people figure when confronted with real problems. In life, real problems are such as buying a radio, buying a refrigerator, buying a bicycle, buying a car, renting a house or apartment, buying a house, planning a trip, taking out life insurance. While money and figuring are involved in

7 Stevens, B. A., "Problem Solving in Arithmetic," Journal of Educational Research, 25: 253-260, May, 1932.

8 Kramer, Grace A., "Effect of Certain Factors in the Verbal Arithmetic Problems upon Children's Success in the Solution," John Hopkins Press, Baltimore, 1933.

9 McMahon, Katherine, "Experiment with a Unit in Arithmetic," Boston University School of Education, 1934.

10 Connor, W. L., and Hawkins, G. C., "What Materials Are Most Useful to Children in Learning to Solve Problems?", Educational Method, 16: 21-29, October, 1936.

11 Harap, Henry, and Mapes, C. E., "The Learning of Fundamentals in Arithmetic Activity Program," Elementary School Journal 34: 515-526, March, 1934.

"Learning of Decimals in an Arithmetic Program," Journal of Educational Research 29: 686-693, May, 1936.

many of these situations, the amount of figuring may be small. More fundamental than figuring is the ability to understand a situation well enough to permit good judgment. That is the very heart of the matter. The real purpose of written problem work should be to develop judgment in business, and this can be done only through carefully developed functional units in which children are led to reach right decisions.

For example, in school the textbook will tell a child that a man ran his car 12,000 miles during the first year, that the car averaged 18 miles per gallon of gas, and used one quart of oil for each 300 miles. The pupil is then asked to figure the cost of operation of the car for one year.

But any car owner knows that the pupil is getting nowhere by such an exercise. Operation costs are not so simple, and one can get little appreciation of operation costs by merely figuring a so-called problem such as the above.

However, a seventh grade pupil can be led to study the cost of operating a car in a manner to make it really worthwhile. It will continue over a considerable period. It will be a unit selected by an individual or a small class group and persisted in over a considerable period. I have known many teachers who have discovered such records and who succeeded in making the records available to the pupils. Then pupils can make a daily record for a considerable time (not less than one month) by consulting at home daily. If half a dozen pupils do this on different cars and then compare notes, they will begin to see what items enter into operating expenses and how they frequently involve more than gas and oil. They will discover that "lubrication" must be attended to regularly, that a spark plug may need replacement, that tires wear out, that engine hoses may occasionally need replacement, that valves may need grinding and re-seating. They may even discover that "depreciation" is a sizable item. They may decide not to include depreciation in operating expenses, because frequently in the first year of operation of an ordinary family car, depreciation may exceed all other items of expense. For this reason, no doubt, it is usually figured as a separate item in car expenses.

However, expenses of registration, drivers' licenses, and insurance must come under operating expenses. It is also discovered that the promised 18 miles per gallon does not develop in ordinary family usage of a car, with much starting and stopping and some idling.

The net result of such careful study of operating expenses is to provide a basis for judgment far superior to that provided by spending one-tenth or one-fifth of a study period (devoted to five or ten text problems) in figuring a text "problem" on car operation. Before such careful study a boy may have been planning to buy a car with the first $25 he managed to save. Now he sees that the $25 paid for an old car is just the beginning.

Business judgment is the real aim of problem work in arithmetic, and this means for each grade the careful planning of a few appropriate units that can be profitably developed on the basis of community and personal ex-

perience. The criteria for written problems suggested by the writer a few years ago[12] have been referred to so often and so favorably by others that it seems appropriate to repeat them here. They may be urged as a basis for completely eliminating isolated textbook problems so-called, and their replacement by functional problem units.

"Criteria for the Setting Up of Written Problems

"1. Providing additional drill material should be no part of the purpose of the problem. Most present textbook problems are disguised drill.

"2. The written problem work should not be subordinated to processes taught.

"3. Wisdom and judgment in decisions on business matters—this is the real heart of the matter.

"4. The problems are necessarily drawn from the community and subordinated to real experience.

"5. This of course means that they must be sizable and pertinent for the group.

"6. Figuring, as such, is secondary, although essential. The teacher helps as needed.

"7. It is true that this work, well done, provides fundamental motivation for drill, but that is not the purpose. The purpose is given in 3.

"8. The setting up of written problem units to meet the requirements of these criteria becomes a matter of concern; it will require familiarity with pupils and community, it will require time. The development of one such motivated written problem unit will often take all class time on written problems for two weeks or a month."

12 Wilson, Guy M., "Criteria of the Written Problem in Arithmetic," Education 59: 459, April, 1934. See also "Teaching the New Arithmetic" (p. 331) by Wilson, Dalrymple, and Stone, McGraw-Hill, 1939.

ARITHMETIC

"No single instrument of youthful education has such mighty power, both as regards domestic economy and politics, and in the arts, as the study of arithmetic. Above all, arithmetic stirs up him who is by nature sleepy and dull, and makes him quick to learn, retentive, shrewd; and aided by art divine he makes progress quite beyond his natural powers." — *Plato: Laws 747B.*

VARIETY IN PROBLEM-SOLVING

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The wise suggestions of this article will be at once apparent to the reader. Problem-solving as a disciplinary exercise or as a response to "cues" has too long held sway in our schools. The children are entitled to something more profitable, more closely related to life.—G. M. W.

THE difficulty which many children experience with arithmetic in school is due in part to the seeming invariability of methods of solving problems. Many children, many adults, and some teachers, look upon arithmetic as a "bag of tricks." To these children arithmetic is but a search for the special trick useful in the problem requiring immediate solution. If one can only find the trick, then all will be well as long as the solution of the problems one faces conforms to the same formula. Such an attack on arithmetic problems does away with the need of understanding. Not only is it useless in practical situations since it is not based on understanding the number implications, even if the social situation involved is in general understood by the child, but it also offers no promise of development in mathematical thinking.

One woman graduate student who wanted to do editorial work was completely confused by the simple addition manipulation presented in making the dummy for the pages of a magazine set in two columns with three possible variations of type size. When questioned about her facility with arithmetic in the elementary school, she said, "I always got the highest marks. I could do any problem if I could find one like it worked out somewhere." "But, you always needed a pattern, didn't you?" "Yes, and I never could see any sense to any other mathematics." I wanted fearfully to tell that woman that she was, and had been, suffering from a complete misinterpretation of arithmetic. Dependence upon a pattern or a cue is not adequate arithmetic thinking.

Textbooks are partly to blame for this idea that if one can find the form of the solution suited to the problem and follow it through correctly one is succeeding in arithmetic. It is common practice in textbook make-up to fill an exercise with problems requiring solutions in similar form. Such an exercise is generally preceded by a sample exercise of the same sort. If I recall correctly that was the form of organization used by Warren Colburn in his *First Lessons in Arithmetic,* and it has been rather consistently followed since. One of the necessary techniques in acquiring arithmetical profiiency is practice, but practice even in computations to be conducive to learning must present a problem significant to the learner which he successfully solves. When a pupil simply follows a model solution, no understanding is necessarily induced; and no matter how many similar problems are patterned after the model, learning does not result

from the activity (for most children.)

A second influence which contributes to the "bag of tricks" definition of arithmetic is the demand that the solution follow certain routine arrangements. Often this is done in the interests of neatness. Other times conformity to the model procedure is demanded because it lessens the teacher's difficulties of marking papers.

These labor-saving techniques, — following a model solution, being neat, conforming to a set formula,—do have their places as efficiency devices if they are preceded by an understanding of the arithmetical and social implications in the briefed story which is the arithmetic problem. But number understanding is best derived from attention to each of the significant details and the variety of ways in which they are related to each other.

One of the first responsibilities of the teacher in relation to problem-solving is to bend every effort to insure understanding. An excellent device conducive to understanding is the practice of having children occasionally solve a problem in as many different ways as they can. The following story illustrates this practice.

Ann, ten-year-old girl of superior ability, was failing in arithmetic in the fifth grade. Diagnosis tests showed her complete ignorance of the meaning of number relations. Her illiteracy in arithmetic was so complete that her special instruction began with the simplest fundamentals of the number series. Since she could meet her tutor only on Saturdays, the scheme of instruction followed was that her work for each successive day was laid out in such a way that she was able by herself to carry forward the ideas which she and the tutor had discussed together. She understood addition, subtraction, and multiplication well, and was working in division when she appeared one Saturday plainly disgusted and completely out of temper. Before her wraps were off, she exclaimed: "I had to stay in three nights this week because I didn't know how to work an arithmetic problem." "Did you finally succeed in solving it?" I asked. "No, I didn't. I expect I'll have to stay in Monday, too." "Do you remember how the problem was worded?" I asked for I noticed she had a work book with her. "Yes, here it is."

This was Ann's problem:

Mother needed 30 cakes for a party. She found that the kind she wanted were 6 for a nickel. How much did mother pay for the 30 cakes?

As soon as I had read the problem I said: "Ann, you know several ways of solving that problem." Ann's expression showed her dubiety of my judgment. "The easiest way will be to draw the facts in that story. Suppose you start by writing: 'Mother bought' then draw the cakes mother got for her first nickel? Be sure to draw the nickel, too." Ann drew the first group of six cookies, then a second, a third, and so on through the fifth group. I suggested that since this was the simplest way of solving this problem that she count cookies until she had drawn the thirty mother wanted. Then she added together the nickels she had pictured and determined the amount of mother's purchase.

"Now let us see if you can solve

this problem by writing out what you know." Ann's second solution looked like this:

Mother bought
6 cakes for 5 cents
(12) 6 more cakes for 5 cents
(18) 6 more cakes for 5 cents
(24) 6 more cakes for 5 cents
(30) 6 more cakes for 5 cents

30 cakes cost mother 25 cents

"Now see if you can solve this problem by 'taking away.' You know how many cookies mother needed. Then, too, you know how many she got for each nickel she spent."

Ann's third solution looked like this:

Mother bought 30 cookies
−6 (1st group)
24
−6 (2nd group)
18
−6 (3rd group)
12
−6 (4th group)
6
−6 (5th group)
0

Mother spent 5 cents 5 times
5 cents
5 "
5 "
5 "
5 "

25 cents

"Does 'taking away' suggest another way you might have solved this problem?" I asked. "Yes," said Ann, "I can find the number of groups of 6 cookies by division. Ann's fourth way was:

	5 groups
6 cookies in a group	30 cookies to be bought 30

5 cents
x5
25 cents

"Now try by writing down the number of cakes Mother could buy for a nickel and see if we can use fractions." Ann's fifth way was:

Mother bought 6 cakes for 5 cents
She bought
1 cake for 1/6 of 5 cents = 5/6 cents
She bought
30 cakes for 30 x 5/6 cents = 25 cents

"I think this is fun," said Ann, "I never expected to think of five ways to do one problem."

Learning purely arithmetic relations illustrates the value of variety in activity. For example, the stages through which a child sometimes passes in learning an addition combination are seeing and counting objects; using computations, that is, using known combinations from which the desired combination can be derived; and finally memorizing the fact which he has experienced at these different levels of understanding. When teaching a child who is not familiar with number relations, the teacher will often find that he does not know that he could compute the sum of 7 and 8 either by the use of the fact $7 + 7$ or $7 + 3$ whose sum he knows, or by a still more difficult computation from $8 + 8$. John, a bright boy who has had difficulty with arithmetic, was taking a quick interview test involv-

ing the 100 addition combinations. He had computed the sum of $8 + 9$ correctly by thinking $8 + 8 = 16$, 9 is 1 more than 8, $16 + 1 = 17$. When he came to the opposite $9 + 8$ he gave the sum as 19. When asked how he reached that sum, he said: "$9 + 9 = 18$, 9 is one more than 8, $18 + 1 = 19$." He was interested to find that he could have got the correct sum if he had watched his thinking in the third step and subtracted.

It is a truism to say that the first step in problem solving is understanding the story. This involves several difficulties often overlooked. The first is reading. Some children in each group will be sure to read too poorly to get meaning. Teachers at each grade-level will need to spend time on reading in arithmetic. There will be the children whose attention is so held by calling the words that they do not get the meaning from their own reading. These children, of course, are reading material too difficult for their present reading ability, but they should not be retarded in arithmetic while they are learning to read adequately. Then there are others whose experience with the ideas, or with words conveying ideas, is not adequate to understand the compressed information held in the problem. These and other types of weakness in reading can be remedied by attention to reading in arithmetic.

Reading should be supplemented by having the story put in the children's own words. Frequently this will involve circumstantial elaboration or imaginative coloring, for the usual text problem presents meaning pressed into the smallest possible compass. The following example of such activity is found in an exercise devoted to telling the story in your own way taken from the *Daily-Life Arithmetics*:[1]

1. Don brought 8 boards for the new club house, Roy brought 6 and Tim brought 5. How many in all?

Here is another way to tell the story:

Don, Roy, and Tim were making a club house. They needed boards. Don said: "I'll bring 8." Roy said: "I'll bring 6." Tim said, "I can find 5." If they all brought the boards, they would have how many?

This interpretation for some, perhaps all, of the children will be enriched by a simple diagram or sketch, such as Ann's drawing in her first solution. Such devices will help each child to hold the meaning down and to follow through the desired solution. For children who have special difficulty in understanding problems a solution carried through in sketch or diagram may be a first step in problem-solving. The story of Ann's solution is an illustration of such a use of drawing. Throughout the successive solutions each was checked for correctness by the facts she knew from her diagram.

A third device in problem-solving illustrated by Ann's solution is the use of writing down what the story tells. As each new type of arithmetic problem appears the teacher can improve understanding by helping the children to write in outline form what is known and the successive steps of its use in solving the problem. Ann wrote down 5 times in succession the number of

1 Buswell, Guy T., Brownell, William A., and John, Lenore, "Daily-Life Arithmetics," Ginn and Company, Boston, 1938, Book I, p. 86.

cakes bought with each 5 cents mother spent. This device may first take the form of a detailed outline prepared by the teacher in which the children only have to complete the solution.

Jack bought 2 apples for 6 cents, 2 oranges for 9 cents, some candy for 5 cents, and a ball for 10 cents. How much did he spend?

Jack spent———|
6 cents for 2 apples
9 cents for 2 oranges
5 cents for candy
10 cents for a ball
Altogether ——
he spent cents

The next teacher-prepared form might be one in which the numbers were omitted from the outline. Such formulated guidance in the correct form of arithmetic thinking prepared by the teacher should become less and less until the children are able to determine the known facts and outline them in their proper relations to each other, obtaining the correct solution of the problem. Each new type of problem in arithmetic could be introduced by this helping device prepared by the teacher, progressing from an almost completely outlined solution to each pupil's independent solution. Obviously, the wise teacher will be careful not to expect children to solve problems involving situations quite beyond their experience and understanding.

NEW CURRICULUM STUDY GUIDES FOR SUPERVISORS AND ADMINISTRATORS

Supervisors and administrators will be especially interested in several recent publications of the Curriculum Laboratory, University of Oregon. Study guides in each of the fields of social studies, language arts, science, and mathematics are built around a democratic philosophy, current practices and specific procedures for developing the school program. These publications are mimeographed and may be secured from the University of Oregon Cooperative Store (Eugene) for 40c, 35c, 25c, and 25c respectively.

Two other publications, *Units of Work* (35c), and *Planning and Teaching Curriculum Units* (25c), are designed to be used directly with teachers in improving instruction and planning units of work. These include a philosophy of unit organization, specific suggestions on activities, materials, the development of the unit in the school, etc.

Any of these curriculum bulletins may be ordered on school credit. A complete list of Curriculum Bulletins may be obtained at the University Cooperative Store, Eugene, Oregon.

A FIFTH GRADE INFORMAL PROBLEM UNIT IN ARITHMETIC ON THE ORDERING AND DISTRIBUTING OF MILK IN THE SCHOOL

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Mr. Shibles and his teachers have made a real contribution by showing how to develop a school activity such as the school milk, or the school sale of cookies, into a valuable functional problem unit. My observation in the Daniel Butler School is most convincing as to the superiority of such work for the pupils.—G. M. W.

NO phase of the curriculum offers greater challenge to teachers, principals, supervisors and experts than does problem work in arithmetic. The fundamental purpose of problem work in arithmetic is lacking in clarity to many. Mixed purposes are prevalent. Teachers as a whole need to extend their professional educational knowledge as to what constitutes desirable problem work in view of the new education.

The field of social studies within the last few years has undergone a remarkable change for the better. Isolated work in geography, civics and history no longer exist in the accepted modern school. Unitary teaching is rapidly becoming the accepted procedure. The illustration of the social studies can be duplicated in the fields of reading, science and functional language.

Recent textbooks in arithmetic indicate an improvement in problems presented for children to solve, but this trend is far short of a desirable goal. At best, these problems are often meaningless and without a real functional purpose.

Teaching of the new arithmetic is based on the purposes of the modern elementary school. When interpreted in this area of the curriculum "the purpose of written problem work is to teach children to use numbers with ease and facility in actual life situations."[1] "The essential characteristic of written problems is the use or development of judgment."[1]

Stated in another manner the aims of problem work involve:

"Objective thinking in terms of real life
Interpretation of real situations when encountered
Ability to apply and use number work when it is needed."[2]

The need for impetus in this direction is further indicated by research. "Since 1930 numerous studies have shown the need for greater emphasis on social arithmetic in order to contribute to the needs of children for more accurate quantitative thinking as contrasted with accurate computational skill. This emphasis upon social arithmetic furnishes a good illustration of the general principle than an analysis of educational objectives, in this case skill in quantitative thinking, is an essential prerequisite for the improvement of a subject."[3]

1 Wilson, Stone, Dalrymple, "Teaching the New Arithmetic," McGraw-Hill Company, 1939, p. 281.
2 Wilson, Stone, Dalrymple, "Teaching the New Arithmetic," 1939, p. 295.
3 "The Implications of Research for the Classroom Teacher," N. E. A., p. 192.

A criteria, such as this, calls for the selection of experiences within the range of pupils that will be vital and meaningful. It enlarges the scope of arithmetic from mere facts and skills. "It means that experiences which are used to develop quantitative thinking must be associated with actual situations."[4]

Accepting the challenge of the new arithmetic in the modern elementary curriculum, that "it is the responsibility of the school not only to develop mastery, but what is more important, to provide opportunities for the application and utilization of the skills and processes"[5] in life situations calling for the use of judgment. This may seem like an impossible task for teachers not skilled in curriculum revision techniques, yet it is conceded that the best results in this regard are derived from teachers, professors and research workers combining and sharing results.

The solution to the problem is nearer at hand than is often recognized. As in the other areas of the curriculum where vast changes have been made, we shall need to look *outside* of the textbook, as well as inside. The vast field of real experiences in and out of school will need to be cultivated. We need to look to teachers who are seeking avenues of instruction through child experiences,—teachers who guide pupils to establish their own purposes or goals for proposed undertakings. We shall need to look to universities that hold the new point of view for expert opinion and council.

Vital problem work of the newer practice is to be found in:

1. School situations.
2. Life experiences of which most communities are rich in number of opportunities.
3. Integrating opportunities with units of work. (The term "integrating" rather than correlating is employed for the full implication of the word is involved. Correlation denotes a narrower aspect relating to subject-matter only.)

The unit reported forthwith is of the first type. This statement must be qualified in that while the *school situation* is the chief vehicle of the unit, aspects of it lead directly to actual life experiences within the homes of pupils and in their dealings in the community. Further than this, phases of the work is integrated, as will be seen in reading the account of the unit, naturally with other pupil work.

These fields of opportunity very naturally lead from one to the other. New experiences, new possibilities for units of work are ever presenting themselves while the activity progresses. These real leads the wise teacher will follow. So successful has this unit been in achieving results from the arithmetic point of view, as well as from social and democratic, that other like units of a more extended nature are now being carried out.[6]

The proposed situation is tentatively planned by the teacher and the approach inaugurated. Pupils establish

4 Lee and Lee, "The Child and His Curriculum," D. Appleton Century Co., 1940, p. 415.
5 Lee and Lee, "The Child and His Curriculum," D. Appleton Century Co., 1940, p. 416.
6 Eddy, Claire, Shibles, Mark R., Principal, "A Fourth Grade Devises a Plan of Weighing and Measuring Themselves Which Leads to an Understanding of Measurement and Weight." This unit was developed in 1939-40, Daniel Butler School, Belmont.
Mullins, Florence, Shibles, Mark R., "A Sixth Grade Buy and Sell Cookies at the Daniel Butler School, Belmont, Massachusetts.
Foss, Helen, Shibles, Mark R., "The Student Government of the Daniel Butler School, Belmont, Massachusetts, Co-operating with a Sixth Grade Plan and Conduct of School Benefits."

their goals regarding the unit and plan what they will do about the situation. The teacher judiciously guides in the development of the unit, offering advice, encouraging, and planning co-operatively in the learning experiences, with problems and number work. Some units developed offer excellent opportunities for integrating other subject matter.[7] Number experiences, thus employed, have a definite functional value and significance to pupils.

School principals and supervisors can do much to inaugurate such a program. They can open avenues for teachers to explore. Encouragement, guidance and help from them will aid greatly in achieving the true purposes of this work.

The skilful teacher will readily recognize many opportunities for functional problem work with the experiences of her pupils in school situations, life situations and integrating possibilities with various subject matter areas. This is a growing field and a promising one.

This unit, "The Ordering and Distributing of Milk in the School," is typical of a possible school situation being utilized by a fifth-grade class and the teacher for vital problem work and is reported at length. The detail and the teaching of this unit was systematically and excellently directed by the teacher to whom professional recognition is awarded.

The school situation.

The ordering and delivering of the school milk can be made a very interesting and fruitful experience for the children and at the same time form a nucleus of an informal problem unit in arithmetic.

The boys in our class had been requested to deliver the milk to the other rooms as it was needed. Because of the size of the milk order and the number of rooms involved it took two boys from the classroom for a period of three quarters of an hour to an hour. Before the boys could deliver the milk they had to report to the principal's office to get a slip of paper giving them the names of the teachers and the number of bottles to be delivered. Then, too, the problem of collecting the empty bottles presented itself. There again boys needed to take time from the classroom. The time depended upon the speed of the collectors and the number of "empties" to be collected.

Delivering the milk.

During one of our class meetings the problem "How Can We Deliver the Milk in Less Time" was presented. We talked over the cause for the time spent in delivery and decided it was due to two things. On Monday mornings it was due to the trip to the office for the delivery slips and then too, the milk delivery necessitated the making of a number of trips to the various parts of the building to deliver milk and returning to the place where all the milk was kept, in order to fill the other orders. Each case of milk contained twenty bottles and the boys carried one case at a time. We decided if we could know before Monday morning how much milk each teacher needed we could save some time there.

7 Comeau, Lucille, Shibles, Mark R., "Off to Market We Go." A third grade unit developed in the Daniel Butler School, Belmont, Massachusetts, embracing the areas of social studies, health, science, language and spelling.

Our next problem was to decide a way in which we could find out before Monday each teacher's order. The following were some suggestions:

"Get the order from the office on Friday night."

"Ask each teacher to let us know how much milk she orders."

"Send a child around to the different rooms and ask the teacher how much she ordered."

"Send different children to different rooms for the milk order and money and let us make up the order for the office."

The class voted to adopt the last suggestion providing our principal gave permission. Permission was granted.

Experience in making necessary forms and using them.

Each teacher had been given an envelope ruled with the following headings: Date — Name — Milk Ordered —Amount of Money—and Free Milk (we are given money to buy a specified number of bottles of milk to be distributed throughout the school upon the suggestion of the teachers and the advice of the principal.) This method had seemed successful so we agreed to follow it. However, we did have to plan how we would manage distributing and collecting the envelopes. We decided that one person would be responsible for distributing the envelopes and the quickest way was to place them in each teacher's mail box in the office on a Thursday night. As for collecting them on Friday we agreed it would be quicker to have a child responsible for a room. Each child who was elected to go for a milk envelope had to rule the envelope he was to use. This gave good practice in planning and measuring for the heading of the envelope.

Figuring the various accounts and establishing business procedures.

Someone asked the question, "How will we know if there is enough money in the envelope for the order?" The question was thrown open to the class. Some suggested to take a pencil and paper and figure it out in the teacher's room before leaving to bring the order to our room; others suggested bringing it to our room and we all figure together. Finally some one suggested that we do as the man at the gas station did — make our price list ahead and refer to that. Because our smallest order was one bottle and our largest order twenty-three bottles we decided to make a price list to include that range. Each person who collected a milk order had a copy of the price list. During the year it was necessary to make out three price lists due to the varying length of the school week. As a result we had a price list for a five day, four day, and three day school week. We had experience in using two methods of finding the cost of the milk—either by the cost per day, or per week. That is to say we know the cost of milk for a day—four cents for a half pint, how much did the entire milk order cost for one day and for the week? We also learned that it was a quicker method to find the cost of the entire order for a week—that is to find the entire number of bottles ordered and their cost, figuring on the weekly basis. Our next experience was learning to write a receipt. It was agreed that when a person paid a bill he should receive a receipt. Therefore, we needed receipt books

and needed to know the correct way to write the receipt and the stub which was to remain in the book. Lessons in writing receipts were given. Upon satisfactory proof that each person responsible for taking orders could write a receipt, a receipt book was given to him. Now the salesmen were ready to take orders and collect money. In order to facilitate matters and to give as many children as possible some responsibility, we followed a suggestion that we appoint secretaries to tabulate the orders on the board for the bookkeepers in the seats. Three secretaries were selected and they tabulated the orders in the following groups: Kindergarten and first grades, second, third and fourth grades, fifth, sixth and remedial class.

Each salesman brought his envelope to the secretary for checking before the order was placed on the board for the children working in their seats.

Placing the weekly order.

The next problem we considered was the method of bringing the money to the office when we placed the order. We learned from the secretary in the office how she had been arranging the money before sending it to the main office. She had slips of paper from the bank in which she rolled a specific amount of money, such as five dollars' worth of dimes. Cashiers were chosen to handle this phase of the work. At the end of their counting the money they prepared a report for the class stating how many pennies, nickels, dimes, quarters, half dollars and bills were received. This was checked with the bookkeepers to see if all records tallied. When this was completed the head cashier wrote out the milk order and collected all the money for the office. Here he placed the milk order for the week with the school secretary, who in turn relayed it to the main office.

Delivering the milk.

The second part of this story deals with the delivery of the milk. It will be recalled that we were concerned with the saving of time in delivery of milk. About the time we were working this problem out a dairy bar opened in our community. It proved to be of great interest to the children and helped us solve our problem of milk delivery.

A youngster recommended that we bring all the milk to our room and as we were near an entrance, have all the pupils come to our room for their milk and then go out our doorway to the playground for recess. Immediately someone inquired what we would do about the smaller children who had recess before we did. After some discussion it was decided to have the boys deliver the milk to those people and then we would have the older pupils come to our room. The boys made a counter from orange crates, and placed a name card for each teacher on a shelf. When the milk was brought to the room it was placed on the correct shelf for each room. The empty case was placed nearby. As each child came for his milk he gave the name of his teacher. The clerk took the milk from that teacher's shelf, checked her list and gave out the milk. The pupil placed the empty bottle in the case and went out for his recess. This method of giving out milk took a little less than ten minutes providing teachers sent pupils down on time.

This method worked so well as a time and energy saver that the boys began timing themselves to see how quickly and efficiently they could not only deliver, but collect the empty bottles downstairs. The delivery boys left empty cases in some of the rooms and in the corridors when safety permitted. This enabled the boys who collected the "empties," as the children called them, to save a little time. The boys worked out this method whereby it took them only twenty minutes to deliver and collect the milk bottles. The cases of bottles were placed by an entrance which was convenient for the regular milk man to pick up.

Integration possibilities.

Other phases of school work besides arithmetic entered into this problem. We studied the value of milk as a food. We planned and gave talks to children in other rooms urging them to drink more milk and to buy milk for recess lunch rather than candy or other sweets they might eat. We told stories about milk to children in the lower grades. We made posters. Safety and courtesy rules were developed. The children began to be very conscious of the amount of milk used in their homes and also interested in the various ways their mothers used the milk.

An aspect of evaluation.

Evidence that the undertaking was a success was presented this fall when the incoming class asked the first day of school if they could work out the same problem. They had talked with the children from the year before. The class that carried on the problem so successfully wished to continue with it, but it was the general opinion that this experience should remain with the fifth for whom it would open up new channels of endeavor. At the present writing the unit is progressing with real interest and success.

This unit on school milk satisfies advanced and progressive problem criteria. It connects with the lives of the children and their immediate community; it has an experience basis. Judgment is called for in the handling of money and in business relations with people. Since it involves money, business, and figuring, it falls in the field of arithmetic.

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Wilson, H. B., and Guy M., *The Motivation of School Work,* Houghton, Mifflin Co., 1941, pages 1-30 shows the development of one of the first functional problem units to appear in educational literature.

ARITHMETIC IN A SCHOOL ACTIVITY

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Miss Lane's story of the arithmetic connected with a school activity well illustrates the possibility of replacing meaningless text problems by something directly at hand and much more valuable.—G. M. W.

WE hear much today of teaching the kind of arithmetic that develops understanding of the processes involved rather than the processes themselves, of making arithmetic really function in the child's actual experiences. If you are looking for a unit for your sixth grade which has limitless functional arithmetic, try publishing a school newspaper. The opportunities are endless, the child interest involved is excellent and the experiences are real. It is really something to collect money from nineteen advertisers, to sell 465 copies of a paper throughout the rooms of your building, to collect five cents for each of those copies, to pay a $23.70 printing bill and to have all your accounts balance at the end of the sales drive. Ours did and were we proud!

We decided that one way to meet our expenses would be to sell advertising space in our paper. We learned that the group which had published the paper previously had charged 25c per inch for adv. space, but that since they had not had to pay such a large printing bill as we were going to have to, they could afford to sell their space at such a low price. We decided that this time we would raise our price 5c per inch making it 30c, and if the advertisers didn't object to that increase too much, the next time we would raise to the more business-like price of 50c per inch. Our Advertising Manager kept the official record of the advs., but each of us was a committee of one to secure them. The following were two of our functional arithmetic lessons. We read each of them over as a group to be sure we all understood them before going to work on them individually.

Lesson I

Below is a list of the paid and promised advs. for our first issue this term of the *Peek Hole*.

9 advertisers have paid for 1″x 2″ advs.
2 advertisers have paid for 2″x 2″ advs.
1 advertiser has paid for a 3″x 2″ adv.
1 advertiser has paid for a 4″x 2″ adv.
7 advertisers have promised us 1″x 2″ advs.
1 advertiser has promised us a 2″x 2″ adv.
1 advertiser has promised us a 3″x 2″ adv.
1 advertiser has promised us a 4″x 2″ adv.

Question 1. How many advertisers have paid for their advertisements?

2. How many have promised us advs.?

3. How many inches of space will our paid advs. require in our paper?

4. How many inches will our promised advs. need?

5. How many inches will all our advs. require?

6. At 30c per inch how much have we collected for our advs.?

7. How much money have we in promised advs.?

8. What is the total amount involved in all our advs.?

9. We had an office credit of $8.99. On April 11th we gave the office $4.20 to deposit in the bank for us. On April 17th we gave them $3.90 more. What is our total office credit?

Lesson II

1. Advertiser A paid us 30c for an adv. Draw a picture of his adv.

2. Advertiser B ordered a 2″x 2″ adv. Draw his adv.

3. Advertiser C has promised us a 90c adv. How many inches will this be? Draw the picture.

4. Advertiser D gave us copy for a 4″x 2″ adv. Draw this adv. and label it with the price. Draw it on your paper the two ways it could appear in the *Peek Hole?*

5. Our largest adv. is a 4″x 4″. Draw a replica of it and name the price. Remember that a column width in our paper is two inches.

Can you imagine the discussion which took place as we read these problems together; questions which arose as to measuring the advs., how to read 2″x 2″, how wide a column in our paper was, the different ways in which advs. could be placed? Surely all this is arithmetic within the child's actual experience. Nothing mysterious here which we can memorize, but not understand!

Spacing copy for our paper was another experience which we found involved arithmetic. We used the following formula to space our copy:

1. Count the words in the article.

2. Divide word count by 6 to find the number of lines.

3. Add four additional lines for title by-line and spaces.

4. Divide line count by 7 to find inches.

We had several lessons on spacing paragraphs to be sure all the children understood the process because everyone wanted to space copy for the paper and Space Editors must be accurate, because so much depends upon their work. This type of arithmetic is not just paper and pencil busy work, but has a practical application.

Next to proof reading the galley proof, making up the dummy is perhaps the most fun of all. For each piece of copy to be printed there must be a dummy article made to be fitted into place on the regular dummy. This involves accuracy in the use of a ruler because each column must total a certain number of inches and if a mistake is made in measuring or cutting, the whole column is "off measure." I found that many children couldn't measure quarter inches accurately. They did not seem to have much difficulty with the ½″ markings, but the ¼″ were confusing. So we had much practice measuring quarter inches, and while we did not have an immediate need for eighths and sixteenths, questions regarding them were asked, so we included them too. Our work was well rewarded when our printer told us that if all his clients sent him such perfect dummies his work would be much less difficult. He also complimented us on the way in which we arranged our advs.

To be sure we had secured all our copies from the printer we counted and stacked them in piles of ten. After all we didn't want to pay for 500 copies and only receive 400!

We gave our room reporters a diffi-

cult task. It was their duty, and all fourteen did it willingly, to keep a record of all papers sold in their rooms. To do this each reporter prepared a sales sheet on which to keep his records. The headings on this sheet were: "Date," "Copies Checked Out," "Copies Returned," "Copies Sold" and "Receipts." Elementary bookkeeping with a purpose! Each time the papers were taken to the rooms, the reporter filled in his sheet correctly. At the end of the sales drive he totaled his columns and made a report to our Business Manager. To be sure there were no errors made, the children thought they should check each other's work. The reports were written on the board in order and all the children checked the figures on scratch paper. While glancing over the work I found one boy's paper on which he had written out the whole process just to be sure he made no errors. His paper looked something like this:

Room 1—11 copies sold x 5c 55c
Room 2—18 copies sold x 5c 90c

Surely this is arithmetic to a purpose and with a meaning! You may say, "But isn't that very elementary work for a sixth grade?" Elementary, yes, but isn't it the kind which most of them are going to need in adult life?

When we elect our business manager there are two qualifications which we always agree he must meet. They are (1) he must like arithmetic, (2) he must be accurate. Last time fourteen children volunteered for the position. Bless their hearts, they all wanted to and they were sure they could be accurate. I am always sorry our staff doesn't need forty business managers rather than two, because it's such a worth-while job. Our business manager keeps all official records, checks all money received and is responsible for all receipts. His record book is really a masterpiece. Not a copy escapes him, not even the one given to our principal for the school file. From his set of records we used the following questions:

1. In our last issue of the *Peek Hole* 19 merchants advertised. They used a total of 31 inches. What was the average amount of space used?

2. a. At 30c per inch how much should we have collected from our advs.?

b. One advertiser moved out before we had collected our money. He had a 1″x 2″ adv. What amount did we really collect for all our advs.?

3. a. Our room sales totaled 307 copies, our outside sales 158. How many copies were sold all together?

b. We gave away 25 complimentary copies. How many have we left of our 500?

c. At 5c per copy how much did we collect for our sales?

4. Our credit balance at the beginning of the term was $10.55. Using the answer of Problems 2b and 3c, what was the total amount to our credit in the office?

5. a. Our printer's bill was $32.70. What is our credit balance at the present time?

b. How much less is this than our balance at the beginning of the term?

The actual handling of so many pennies, nickels, dimes, quarters, half dollars and yes, even dollars, was an experience in itself, to say nothing of the accuracy with which one had to

place decimal points when adding these amounts on paper. Sometimes as many as six children would count the money before any two could agree, but they kept to the task until they were all certain the amount was correct.

We used our new microphone to announce the sale of the *Peek Hole* and we think it was because of this that our last issue sold more copies among the children than any other issue in the past two years. The staff appreciated the coöperation of the other children and wanted to let them know by some means the results of the sales drive. We discussed several ways of showing sales and finally decided that a graph would be the best. Immediately one of the children said that it wouldn't be fair to count only the number of papers sold, because some rooms had more children than others; the kindergarten, for instance, had almost twice as many children as the other rooms. One of the girls told the group that the P. T. A. always figured such things on percentage. With the official office classification and our reporter's records of room sales, as a group, we figured the percentage of sales for each room. When this was completed each of the children made a graph showing this percentage and two children were chosen to make the large chart to be shown to all the rooms. There was a good bit of discussion as to the clearest way to show the largest percentage, but the committee finally decided to use the school colors of blue and gold for their graph, using gold for the highest percentages in primary and upper grades and blue for all the others. This activity was a very nice one with which to close the sales of the current issue.

If it is true that association between learning and experience makes learning more meaningful, I feel sure that any group which has experiences of this kind with an actual school newspaper has really enjoyed a year of meaningful experiences with arithmetic.

INTRODUCING THE FUNCTIONAL PROBLEM UNIT IN ARITHMETIC—WHY?

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Miss Shea's experience as a supervisor in introducing the functional problem unit to the teachers of two towns in Rhode Island should provide inspiration and valuable aid to teachers and supervisors throughout the country.—G. M. W.

A FEW years ago it was my good fortune, while studying at Boston University, to become keenly interested in the Functional Problem Unit in arithmetic. Some time afterwards, through the kind cooperation of my Superintendent, who had also studied that same phase of arithmetic, I was privileged to introduce it to the teachers of the two towns which were under the supervision of my superior.

In making this introduction, these five elements had to be considered, namely: teachers, pupils, textbooks, parents, and limits. It is a recognized fact that, for successful development of Problem Units, teachers must be made to realize that the child's arithmetical problems must be linked with his own experiences and that problems must be brought down to the child's level of understanding. Teachers must also be shown that the teaching of arithmetic becomes more interesting through the idea of the Problem Unit. The child must be taken into consideration and arithmetic must be vitalized for him. He must be given the opportunity to acquire an understanding of those situations that are to be found in his immediate environment and he must develop the ability to handle problems arising from these situations.

Textbooks may be analyzed by the teachers and studied to show the utter uselessness of the majority of textbook problems as contrasted with the value of the Functional Problem Unit in so far as the individual child and his community are concerned.

The coöperation of parents must be sought as it is very necessary in the introduction of this type of work. They also must be shown the value of the Functional Problem Unit over the written problem of the average textbook. The limits to which a teacher may go in introducing and developing this work must be given careful consideration. Of course, the traditional background of the community in which the school is located always affects this element of the work.

The purpose of the introduction was to lead teachers to choose to replace the isolated textbook problem with worthwhile Problem Units.

The first step in the procedure (with the teachers) was carried out by carefully presenting a history of the results in arithmetic and the apparent causes. This was traced from the day when the textbook containing the answers was in vogue, to the present day when the answers are eliminated from the pupils' books. Along with this was presented the story of the marked increase in failures in arith-

metic and the unconscious development of a hatred of the subject on the part of the child.

The second step was to show teachers that in order to overcome these failures they must realize that *the child is the chief consideration,* that arithmetic must be vitalized for him by linking it with his experiences.

As the third step, the teachers were shown how the majority of the text-book problems are absurd and lacking in real value for the individual child. Dr. Wilson's "problem test" was used for this purpose, each teacher being requested to check the ten best problems, all being more or less absurd. This "test" is designed to show that if teachers do not understand the situations involved, they may work with absurd numbers and be complacent over absurd answers.

Then came the fourth step, which consisted of the presentation to the teachers of three Functional Problem Units worked out in detail. These units covered the primary, intermediate, and upper grades. They had been developed by the writer with the children of her own school and coöperating schools. A thorough explanation of the development of these units was given to show that good, worthwhile units in arithmetic can take the place of the written problem of the text and in so doing make the subject more vital and valuable for the child and the teaching of it more interesting to the teacher.

To complete the fifth step in the procedure each teacher was requested to try to work out one Problem Unit with her class. She was urged but not required to do so. She was to list all facts as to how approached, conditions under which class worked, and then present her plan to me. Many personal conferences were arranged.

As a sixth step teachers were asked to seek the coöperation of parents and adult members of the community. (Experience proved that such coöperation is gladly and whole-heartedly extended.)

The final step consisted of collecting the units and evaluating them. Many fine units were among those collected, including a Christmas Card unit in the development of which the children made the cards, printed verses on them, made envelopes to match, and held a card sale. They arranged the cards on a large table, put the prices on them, and made play money. Each pupil was given some money, went to the store, and purchased some cards. This project was carried on in a one-room building housing the first five grades. Another interesting unit was the Candy Shop in grade two. The children saved wrappings from gum and candy bars that they had purchased. These wrappers were filled with torn newspaper so that they resembled the original candy bars. They were arranged on the counters with display cards advertising them, which the children had procured from storekeepers who were no longer using them. The children made their own money and purchased candy at the shop. While such work has admitted limitations, it is better than the usual text-book work, and it later led to better units.

Among other worthwhile units were the Grocery Store, Post Office, Flower Shop, Furnishing a Living Room,

Furnishing and Equipping a New Kitchen, Vegetable Stand, Toy Shop, Building and Furnishing a Six-Room House, Equipping a Small Machine Shop, and a Trip to New York.

Since the introduction of the unit idea, many fine units have been evolved, including an exceptionally splendid one developed by a group of five eighth-grade boys, — A Hunting Trip to Moose Woods. A situation such as this, in which pupils are keenly interested, may be used as the basis for a good Problem Unit regardless of the fact that the situation does not come within the scope of their own immediate environment. In carrying on this unit the group corresponded with the Department of Publicity, Winnipeg, Canada, wherein Moose Woods is located. This department coöperated whole-heartedly with the boys and much valuable information and help was received, permitting careful estimates of expenses for the trip.

A fine individual unit, worked out by an eighth-grade boy was—Building a Six-Room House. Plans were drawn and the prices and quantity of materials were procured from nearby lumber and building and construction companies. The boy constructed a model of the house which he later sold for three dollars. The plans drawn for this house were among the finest yet drawn by a student of grade eight.

Why did we introduce the Functional Problem Unit? Primarily, to improve arithmetic in our schools. In so doing, we have, unconsciously perhaps, strengthened the principles of democracy. For the successful development of any real Problem Unit calls for a social-democratic set-up in the classroom. Problem Units make possible the development of life situations in the schoolroom through which pupils learn the meaning of real problems, which motivate drill for those pupils who need drill. The teacher arranges certain, definite outcomes which she means to attain by the use of each unit and such outcomes include the development of good business judgment and an understanding of fundamental economic principles as well as the development of skills in computation.

The Functional Problem Unit challenges! It is a *real problem*. It challenges the pupil to rub elbows with outside agencies, to search for and gather the necessary facts, data, and statistics with which to solve the problem presented in the unit. When he has solved it he realizes he has accomplished something worthwhile and the knowledge thus gained will be of value to him not only then but in situations which may arise in his adult life later. Thus arithmetic becomes a vital, pleasant, self-satisfying part of child experience. The child gains a complete understanding of those aspects of life that he sees, hears, and reads about plus broad and varied views of social life. He will lay the foundation for handling any problem arising out of situations to be found in his own immediate environment. This will make him a more intelligent and efficient citizen—and is this not the ultimate aim of all good teaching? Does not this fact alone suffice to warrant the introduction of real Problem Units in

Arithmetic? It should entirely replace the isolated written problems of the textbook, which have little or no value to children. It gives genuine opportunity for the realization of one of the vital purposes of arithmetic, viz. acquaintance with business and business practices, and judgment in business decisions. The Functional Problem Unit permits the pursuit of this aim, not chiefly through words in a textbook (frequently meaningless,) but through real contacts, real experiences.

ARITHMETICAL GAMES

"All freemen should learn as much of these branches of knowledge (mathematics, astronomy, etc.) as every child in Egypt is taught when he learns the alphabet. In that country alphabetical games have been invented for the use of mere children, which they learn as as pleasure and amusement. They have to distribute apples and garlands, using the same number sometimes for a larger and sometimes for a lesser number of persons; and they arrange pugilists and wrestlers as they pair together by lot or remain together, and show how their turns come in natural order. Another mode of amusing them is to distribute vessels, sometimes of gold, brass, silver, and the like, intermixed with one another, sometimes of one metal only; as I was saying, they adopt to their amusement the numbers in common use, and in this way make more intelligible to their pupils the arrangements and movements of armies and expeditions, and in the management of a household they make people more useful to themselves, and more wide awake; and again in measurements of things which have length, and breadth, and depth, they free us from that natural ignorance of all these things which is so ludicrous and disgraceful."

— *Plato: Laws 819B, C.*

A PROGRAM OF INDIVIDUALIZED PROBLEM UNITS

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Miss Kett's story of replacing isolated text problems by functional problem units merits careful study and imitation. One such unit developed with children will do much to convince a teacher of the value of the pupil's own problem over the meaningless text problems.—G. M. W.

WHY teach arithmetic in school? Are you one who believes that arithmetic should be taught because it trains the mind? No, you are not. You know that arithmetic has an important place in the elementary school program because you hope to help children to solve problems accurately when they meet them in life. To the teacher who believes this, but who feels that children dislike problem work and so do not progress in their ability to solve them successfully, this article is written with the hope that it may be helpful.

I wish here to make three definite statements: (1) Children like to do problems, — when the problems come out of their experiences. (2) Children can solve difficult problems,— when they and their classmates help make the problems. (3) You and I are to blame when children fear and dislike problem work in arithmetic.

We have asked children to try to solve problems about things entirely outside of their experience. We have been guilty, but we are not doing all we can do to make up for our errors of the past. In good schools everywhere today, children are doing interesting and worthwhile functional problem units. Today children are living and working together in their worlds at school and out. They are banking, budgeting, planning. They are citizens, and as citizens they have real problems which we are helping them to solve.

Approach.

There is no fixed approach to the original problem unit. The interests and backgrounds of the group of children with whom we are working must be the determining factors. This will be made clear by a brief description of a group of thirty-four sixth-graders with whom a program of individual problem units was carried out. In the group, I. Q.'s as determined by group intelligence tests ranged from 67 to 176. Their interests and backgrounds showed nearly as wide a range. (Many of you will have groups similar to this one.) Several came from well-to-do families. These children traveled a good deal, had their own spending money, and went to summer camps. Others in the group seldom left their own town and worked for what spending money they had. Thus we see here two distinct groups: (1) Those to whom money came easily (allowances,) (2) Those who worked for their spending money and who often bought some of their own clothing. The teacher discovered though that in both groups there were many children

who were keeping accounts, budgeting, dealing in real problems every day, though of course they did not recognize them as problems. Why? Because they wanted to do them. It was fun to figure one's profit on magazine or paper sales. All the teacher of this group had to do then was to invite the children to bring their home problems to school instead of taking school problems home. It is lots more fun and really much more worthwhile.

Class Discussion began something like this:

Teacher: How many of you do any arithmetic outside of school?

Response was slow. The teacher discovered that it was because the children didn't consider that the kind of figuring they did at home was arithmetic. The latter was fun and arithmetic was something one did from 9.30 to 10.30 each morning.

Teacher: John, you have a paper route, haven't you?

John: Yes, Miss Kett.

Teacher: Do you keep an account of the number of papers you sell? Do you figure how much of the money you take in is profit?

He did. The teacher assured him that he was doing arithmetic and the most valuable kind of arithmetic.

The ball began to roll. Jack saved a part of his allowance each week for camp. Mary helped with the baking on Saturday. Often she had to increase or decrease recipes. Was that arithmetic? It certainly was.

Teacher: Instead of doing problems from our textbooks, would you like to bring your own problems to school, work them out here, and write them up?

The children were very enthusiastic. They didn't like problem work, but thought this kind might be fun. The children were to think the matter over until the next day. Those who did no arithmetic at home might like to plan trips for the family for the coming summer. Others might like to plan menus for a week and do the family buying. They were to talk things over at home that night. The next day we would make definite plans.

Discussion Continued.

Harry: Miss Kett, I have been wanting my father to screen our porch for two years. We talked it over last night and he said that if I would figure the cost he might do it this summer. So I wish to call my unit "The Cost of Screening Our Porch."

Two boys and two girls decided to plan menus for a week. Their parents became interested and told them how much money they could plan on. It would be fun to see if they could plan as good meals as their mothers did and keep within the budget. (Incidentally we would talk about balanced meals in another class.)

Several families were planning to take trips to the New York World's Fair that summer. Two or three children decided to figure the cost of such a trip.

Some of the children planned to go to camp in July. They would figure the cost of tuition, clothes, equipment. Those who had jobs or allowances could save something toward expenses. How much would the family have to pay?

One or two girls who were quite clothes conscious decided to plan their wardrobes for the following year. They would be going to Junior High in September. Clothes are important in Junior High.

These suggestions were listed on the board. Each child decided for himself what his problem unit for the next three or four weeks should be. We had made a good beginning for two reasons: (1) The children were very enthusiastic. (2) The parents were interested and coöperative.

How Class Periods Were Planned to Take Care of Individual Needs.

In order to get the children started, the teacher talked with the whole group about how to begin. For tomorrow let's bring to class any materials or information which we may need in order to begin work.
Examples:

1. Measurements of porch in order to make a drawing to scale.
2. Road maps.
3. Catalogues for clothes or camp equipment.
4. Cook books.
5. Sales sheets from grocery stores, etc.

From this time on, class periods became laboratory periods. At the beginning of each lesson the teacher asked, "How many of you need to have a conference with me before you can begin work today?" These children she took individually or in groups, helped them over the hard spots and then sent them to work independently until they met with more difficulty.

Did we have no drill during this period? Oh, yes—when we recognized a need for it. Alice said one morning, "I have to buy 2¾ pounds of hamburg this afternoon. I know it costs $.30 a pound, but I don't know how to find the cost of 2¾ pounds. Her wise and coöperative mother had asked her to figure out how much money she needed in order to buy groceries for supper. A less helpful mother might have given the child enough money to cover the cost and let the grocer do the figuring. Several other children had similar problems and others would have before they finished and so Alice's question turned the day's lesson into a drill or semi-drill period. Others from time to time asked similar questions.

The units were written up and attractively illustrated. The children decided to invite their parents to see them. Before doing so, they decided to read each other's papers. While they were doing so, the teacher noticed them adding each other's columns, using dictionaries to check on spelling. When they found mistakes they took the papers to the owners for correction. There was a grand spirit of giving and taking criticism.

Description of Two Units.

I Screening Our Porch.

Harry chose to work on this because he had been wanting his father to screen their open porch. His father said he would sometime, but couldn't afford to right away. Harry thought perhaps he could show his father that it could be done quite reasonably.

Activities Involved.

1. Drawing porch to scale.
2. Visiting hardware store to obtain prices.
3. Figuring total cost.
4. Writing up the unit.

II A Trip to New York World's Fair.

Carleton and his family hoped to take this trip in July. Carleton decided to figure the cost of such a trip and figure also how much he could contribute toward his own expenses.

Activities Involved.

1. Use of road maps to figure distances.
2. Figure how many gallons of gas they would use. Figure total cost of gas, oil, garage.
3. How much for food and lodging for whole family? For himself?
4. How much for amusement (Carleton found that most of the best things at the fair were free.)
5. How much would the family have to pay of his expenses?

Skills and Appreciations that Come From This Work.

1. The children thoroughly enjoyed doing this kind of problem work.
2. They understood the importance of *accuracy* in computation. They saw the need for drill.
3. They realized that careful attention to written expression, spelling and penmanship were necessary if they hoped to interest others in their units.
4. Illustrations (maps, drawings, designs) made their papers interesting.

(The girls who planned wardrobes designed some of their dresses because they were unable to find what they wanted in catalogues.)

5. They learned to give and take friendly criticism.
6. They saw arithmetic in a new light, a light that showed its usefulness in daily affairs.

NUMBER

"He who never looks for number in anything will not himself be looked for in the number of famous men."

— *Philebus 17 E.*

ARITHMETIC IN SOCIAL SERVICE

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This article demonstrates that even at the second grade level worthwhile opportunities can be found for problem units in arithmetic.—G. M. W.

MY second grade class, while discussing Thanksgiving and our much advertised Community Chest Fund, decided they would like to do something to help the needy. A suggestion was made by one youngster and unanimously seconded by the class, that we buy a Thanksgiving dinner and supplies for a family less fortunate than ourselves.

After discussing means of raising money and the amount needed, the class decided on a candy sale. With the aid of four class mothers and the Home Arts teacher, who secured the necessary ingredients, we made fudge, peanut clusters, chocolate covered marshmallows, fondant, stuffed dates, fruit balls and pop corn. Every child in the class participated in the work, mixing the ingredients, making the candy, and washing and drying the utensils.

The children made posters advertising the sale, hung them in the corridors, and sent a schedule to all the classes, giving each class a definite time during the following school day when they might patronize the sale.

Four sixth grade children were invited to supervise the cashiers to ensure no mistakes in giving change, but my class did the selling and acted as cashiers. Each child had an opportunity of selling and cashiering, giving them experience in handling of money and making change. The candy sold for a penny a piece, but no child was permitted to spend more than five cents. The sale was well patronized as evidenced by the fact we sold 1,564 pieces of candy.

After the sale the children separated the different coins in piles of the same denominations, then they counted the totals and found they had $15.64. From this sum we took $4.97 to reimburse the Home Arts teacher for the ingredients used in making the candy. We found we had netted $10.67. We took $10 in coins and put them in piles of ten each to be sent to the bank for ten $1.00 bills, for convenience in making our purchases.

I located a needy family with three children through the Department of Social Service and the class decided what supplies we should buy such a family with the money in our treasury. We finally concluded on a twenty-pound turkey and the fourteen items listed herewith:

1. 1 bag of oranges
2. 3 bunches of carrots
3. peas
4. cabbage
5. potatoes
6. 3 qts. of milk
7. 1 lb. of butter
8. 2 dozen eggs
9. Jello
10. canned vegetables
11. flour
12. sugar
13. bread
14. candy

The fourteen items were written on the blackboard and were allocated to the twenty-eight children in the class by giving the responsibility of each item to two children. After our plans for purchasing the supplies were completed, the entire class went to a neighboring store to make the purchases. (I previously had counseled the clerks and they filled the children's orders and delivered the goods into their own hands.) Each child kept an account of what he helped to spend at the store, on a slip of paper given him for that purpose.

On returning to the classroom we added the amounts taken from the slips of paper and found we had spent $9.99. After deducting the $9.99 from the $10.67 in our treasury, we had 68 cents left with which to buy a book for the classroom and bird seed for the class canary.

We carefully packed the turkey and supplies in four boxes and the same day two class mothers delivered the boxes to the needy family. The following day a lovely letter was received from the grateful recipient. After reading the letter to the class, I deleted the signature so the children would not learn the name of the impoverished family, and placed it on the bulletin board. The children were thrilled with the knowlede they had done a real social service.

Activities planned by teachers receive the commendation of progressive administrators, but it is a moot question whether or not the children enjoy them. However, the class voted at the end of the year that this activity was the best of our many activities because it was helpful to others and at the same time they had a lot of fun.

This activity which includes much arithmetic teaches social service and home arts, unites the school and community, while the children gain in economic and social understanding. The emphasis is of human relationship and the contributing factors, the arithmetic serving a truly useful purpose.

FROM CONCRETE EXPERIENCE TO THE HIGHER MENTAL PROCESSES OF ARITHMETIC

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The necessity of understanding or meaning as a basis for learning cannot be too often nor too strongly emphasized. Doubtless today all educators hold to the meaning theory of learning so-called. No one would hold out for drill without meaning and those who advocate the incidental approach do so in order to guarantee meaning before drill starts.—G. M. W.

SOME of the readers of this article will recall a period in education when children were taught the facts and processes of arithmetic abstractly before they were expected to apply them. Many more will recall the advent of the project method with the insistence that the progress of arithmetical learning is from the concrete to the abstract. There are few, if any, in the teaching ranks today who do not subscribe to this idea. It is the purpose of this discussion to evaluate present-day practice in the light of this principle.

Almost fifty years ago McLellan and Dewey stated their conception of what they thought should be the connection between concrete experience and number thinking on higher mental levels. They phrased it in these words:

"Numerical ideas can be normally acquired, and numerical operations fully mastered only by arrangements of things —that is, by certain acts of mental construction, which are aided, of course, by acts of physical construction."[1]

Obviously McLellan and Dewey placed a high premium upon "acts of mental construction." They did, however, suggest that these should be "aided, of course, by acts of physical construction." What McLellan and Dewey thought the connection between the acts of mental and physical construction should be was explained more fully in another statement:

"Number is not (psychologically) got from things, it is put into them."[2]

Significant in this quotation are the words, "it is put into them." They imply a connection should be made between the physical activity and the numbers used to describe that activity. If the connection were only for the purpose of giving verification to the manner in which numbers are recorded and operated, McLellan and Dewey would not have mentioned "acts of mental construction." These words clearly indicate that they were of the opinion the learner should gain number ideas by acts of thought. Interpreted more broadly, arithmetical learning should be an active rather than a passive process. It is in this respect that much of the present-day classroom procedure in arithmetic may be challenged.

Although pupils may engage in activities involving concrete materials before they make the number records which describe these activities, it does

1 McLellan, James A., and Dewey, John, "The Psychology of Number," A. Appleton and Company, 1906, p. 61.
2 Ibid., p. 61.

not necessarily follow that they perform "acts of mental construction." For example, it is not uncommon when a new skill is introduced to first provide children with the opportunities for manual occupation and then give them the skill in ready-made form. Outstanding leaders in arithmetic teaching have agreed that instruction in arithmetic can be so organized and directed that number ideas are deduced because children think numerically about the activities in which they engage. Descriptions of such teaching procedure on several grade levels are offered in support of this contention.

A. The Number Combination Concept.

The problem at hand may be to divide a given number of coins, crayons, pencils, etc., between two children in as many ways as possible. Suppose four articles are to be distributed. The distributor may begin by giving each one the same number. He may be challenged to give each child in turn more than the other. The division in each case would naturally be recorded by the children. Thus four would be distributed as 2 and 2, 3 and 1, and 1 and 3. Likewise five articles might also be divided and the records 4 and 1, 3 and 2, 2 and 3, and 1 and 4 obtained. Insight might be increased by asking children to demonstrate the different number records with the objects at hand. Very soon an abstract number such as 7 might be presented with the request that the children indicate with numbers the several ways by which 7 articles could be divided. The children who are able to write 6 and 1, 5 and 2, 4 and 3, 3 and 4, 2 and 5, and 1 and 6 without actually manipulating concrete objects, it would seem, have gained a number idea. A real connection has been made between the concrete and the abstract.

B. Carrying in Addition

In this instance the problem may be that of finding the sum of two amounts of money. Suppose the amounts are $24 and $58. From the supply of $1 and $10 bills at hand the two amounts would be counted out. When putting the $1 bills together, the pupils would find they had a sufficient number to obtain one $10 bill and have two $1 bills over. They would count a total of eight $10 bills. A number record of the usual type, i.e.,

$$\begin{array}{r} {\scriptstyle 1} \\ \$24 \\ \$58 \\ \hline \$82 \end{array}$$

would be made. The children would be asked to indicate what, for example, the 2 in 82 means, what the small 1 over the 2 in 24 signifies, etc. In a like manner sums of other amounts would be found and number records made of the activities involved. Analysis would be made of the number records. Following a few repetitions of the above procedure, the children would be challenged to show with numbers alone what the sum of two given amounts of money would be. The ability to obtain sums through the operation of numerals without the accompanying manipulation of objects represents the first step toward number operation on the abstract level.

C. The Addition of Simple Unlike Fractions.

Early in the study of fractions, children might find a need to add simple unlike fractions such as 1/2 and 1/4, 1/2 and 1/8, 1/3 and 1/6, 1/3 and 1/9, and the like. Children taught with the idea of "putting number into things" would place the unlike fractional parts together concretely. They would find it necessary to change one of the fractions in order to name the total. For example, if 1/2 and 1/8 are placed together, it would be necessary to mark or cut the 1/2 into eighths in order to name the total. The record of this activity would be the familiar

$$\begin{array}{r} 1/2 = 4/8 \\ +\ 1/8 = 1/8 \\ \hline 5/8 \end{array}$$

Other fractional parts such as 1/2 and 1/4, and 1/4 and 1/8 would be put together, the larger adjusted to the smaller, the total found and the activity recorded. At the opportune time the children would be challenged to show with symbols only how they would put, for example, 1/3 and 1/6 together and find the sum. Ability to do this would depend upon the deduction that the larger fraction must be thought of in terms of the smaller in order to find the sum. It should be noted that rules or descriptions of the mechanical process do not play a part in teaching which seeks to have children think the step between the concrete and the abstract.

Other illustrations could be supplied to further demonstrate the application of the principles enunciated by Dewey and McLellan. So long as textbooks and teachers give children rules and verbal descriptions of the steps in a given process, they will not be required to "put number into things." In the majority of the arithmetic texts are found rules and adult explanations for the addition with carrying and the addition of simple unlike fractions. For example, the rule for adding fractions having different denominators is usually stated as, "First change them to fractions having the same denominator." The rule for this usually is, "To change a fraction to an equal fraction with a larger denominator, we must multiply both the numerator and denominator by the same number." Children who perform "acts of mental construction" about "acts of physical construction" to the point that "mental construction" may proceed without physical construction," are in a fair way to taking the step from the "concrete" to the "abstract."

The psychology of meaningful teaching suggests that textbooks and courses of study should not contain rules and explanations, but instead directions for activities with questions and suggestions to guide and aid children in generalized thinking. Teaching with such textbooks and courses of study will raise new problems, some of which appear to be:

1. Grade placement of topics of arithmetic will be governed by the ability of children to comprehend.

2. Materials will have to be brought into the classroom from the manipulation of which children will have basic experiences which in turn will be described with numbers.

3. The chief concern of the teacher and the measure of her success will be centered in the manner in which thinking is stimulated and guided.

Those who have attempted to direct children in the discovery of larger principles know that it is not an easy task with the grade placement in arithmetic which is in vogue at the present time. They realize, for example, that certain parts of topics such as long division, the multiplication and division of common and decimal fractions, ratio and percentage, are not within the comprehension of many children of the grades in which these topics are now taught. Many teachers consequently despair in their efforts to teach meaningfully and resort to teaching these difficult topics by the methods of teacher explanation and presentation of model solutions for the pupils to imitate. Now that almost one hundred per cent of our children stay in school through the ninth grade, many things taught during the first six years could be moved into the junior high school grades. There is, however, need of research which will indicate in what grades children can deduce the ideas and principles which are inherent in our number system. We should realize, too, that many of the "higher processes" have only appreciational value for most grade pupils.

In a program of arithmetic teaching which aims "to put number in things" written problems also assume a new status. They represent situations which the pupil interprets in the light of past experiences. Their solutions become the pupil's way of dealing symbolically with "acts of physical construction." Although the original "acts of physical construction" may be lost in a long series of experiences on a symbolic level, they nevertheless serve as a background for problem solving. It would therefore seem that the chief purpose for which arithmetic is taught, to develop ability to solve problems in life, has its roots in teaching which aims to make the connection between the concrete and the abstract a real one.

What progress is made in the direction of changing arithmetic from a subject concerned with the acquisition of skills per se to one which challenges thinking will depend upon many factors. The plea made in this discussion is by no means a new one.

OUR GROCERY STORE

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Teachers are helped most quickly to newer and better concepts of problem work by observation of a smoothly working problem unit. The next best thing is a careful report of a problem unit. The store unit here reported can be adapted to any community. All prices and practices must be right for the community concerned.—G. M. W.

PROGRESSIVE Education is the process of developing the child's interests into a world that for him is a new world. It is a world of new knowledge and understandings that articulate with and enlarge his former self.

The walls between subjects and subject matter have gradually melted away. Now our subject matter starts with the child, his interests and needs. Knowledge must be real and usable.

Our newer type of education fits the needs of every child. The brighter child develops leadership and coöperation. The middle group learns to develop appreciation of leadership and why leaders need his contribution. The slower group no longer "sit" or become serious juvenile problems. Through activity they find their level of achievement, why and how they are needed by society. Better social attitudes are gained. Thus, to a large degree the problem of juvenile delinquency is solved.

One of the most important developments in our new program is the teaching of arithmetic. Arithmetic is a system of inter-related principles that children become interested in learning. There is a place for drill in the process of learning, but purposeful activity must be the core and the source of motivation. One of the best activities or units for any grade in the elementary school is the store. Many phases of arithmetic can be developed and mastered. The types of stores are many according to grade, season of the year and objectives. A few possibilities are grocery store, vegetable stand, furniture store, roadside stand, linen shop, dry goods and January White Sale. These among others have many possibilities, depending upon the interests of the group.

The remedial group has at last found an answer to its problem. Over age, mentally retarded, out of place in a regular classroom, the new emphasis on activities fits their needs and interests.

My remedial group comprises nine boys and six girls. Their ages range from ten to sixteen years. The intelligence quotients range from 50-89. Formal education offered nothing. Very slowly we have developed a remedial program on purposeful activity.

One unit which the children enjoyed this fall was the grocery store. Many phases of arithmetic were reviewed or developed according to the mental age and needs of the various groups. The arithmetic involved has given them power to make intelligent and accurate use of numbers in their everyday life.

The arithmetic period had lacked

interest and consisted mainly of drills. Motivation of any new process seemed impossible.

At the close of an Indian Unit the contrast of our foods and the foods of the Indian created a desire to find out where our foods come from, how they are preserved and why we can enjoy a wider variety. We decided to collect various types of cartons and cans to find out where our food comes from, how it gets to us, and how it is preserved. Labels were read, the various places located on our map and listed on the board. Individual food maps were made and mounted. This involved measurement, reading, map work, oral discussion and art. The question of the prices and the reasons for the range of prices, signs and how our display could be enjoyed by others was considered. Counters and shelves were needed, therefore, we reviewed measurements, and made signs involving dollars, cents and decimal points. Next we decided to organize our store into departments. A refrigerator was needed for our dairy products, a safe and cash register, plus scales were necessary. The older group enjoyed making the safe, cash register and refrigerator. The problems of health, sanitation and civics were interwoven. The relationship and dependence of the city and country upon each other was emphasized.

Every child was eager to play store, make posters to decorate it, and attractively arrange signs for daily or weekly special sales. Addition, subtraction and multiplication were used again and again in meaningful situations rather than as abstract drills. The children's enthusiasm resulted in many store owners contributing display cases and attractive advertisements. In this way better social attitudes and an improved community spirit were fostered.

The older group enjoyed developing charts involving overhead expenses. Rent, light, heat, telephone, water, insurance, the cost of buying and running a truck, cost of clerks, managers, truck drivers and assistants were developed. The office details were not forgotten. Making checks and money orders, endorsing, where and how to cash them proved most interesting. Bills were made out, mailed, delivery slips were checked, the day's receipts were balanced and deposited in the safe. Occupational guidance, personal appearance, courtesy, safety, civic pride, respect for others' rights, were valuable outcomes. Our office as well as our manager's department contributed oral and written language, spelling, penmanship and reading. To me, this phase of the unit was most satisfactory. With very little guidance, this group developed their problems and solved them, then gave an excellent oral report at a meeting called by their chairman. The cost of overhead was explained in detail.

Two members had been serious discipline problems. Now, they are kind, sympathetic leaders and idols of the younger group. Poise, personality adjustment and confidence have been gained.

The outcomes of this unit were numerous. Among the most outstanding: individual differences were cared for, personality adjustment was achieved, improved social attitudes of the whole group resulted, increased

opportunities for the development and improvement of skills were gained.

I am confident the interest created has carried over. My children have just announced to me that they are planning a repair and service station featuring speedy, courteous twenty-four hour service. The tourists passing through our city would enjoy this new garage.

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JENNY

Jenny stands where the wind blows across her shoulders;
She raises her face to the sky, her strong arms wide
To orchards of cherry and peach; to vistas reaching
In billows of green to the meeting of land and tide.

Jenny's old eyes are quiet and clear and steady;
Her little white cap turns pink in the sunset's glow.
Maybe you've guessed that Jenny is our old mountain,
And her little white cap is a little white cap of snow.

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NUMBER EXPERIENCES OF 390 CHILDREN FROM GRADES 3-6 IN AN URBAN AREA

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Here is a significant study on the uses which children find for numbers. We must not forget that if we teach, we teach children. The form of Mr. Ellsworth's study is such that it may easily be repeated by any teacher or school system. Such studies greatly help a community and its schools in understanding each other.—G. M. W.

THERE has been a gradual realization that the problem phases of arithmetic have significance for children only so far as they have the proper experience basis of such work. A few studies of the number experiences of children are available. Noon found children's uses of number so meager that he recommended defering significant efforts in arithmetic to grades 4 or 6[1]. Smith found that first grade children had number contacts, but cautioned against carrying children beyond their experience basis.[2]

Ray[3] and Rogers[4] studied more specifically the understanding of simple business (problem) situations by children in lower grades and intermediate grades. Wilson studied the comprehensions of measures and the measuring of commodities by children grades 3-12, and by adults.[5]

The study[6] on which this article is based was made with 390 children of third, fourth, fifth and sixth grade level. It was a very diversified group, socially, economically, and mentally, with pupils of different nationalities and races included.

After discussing and evaluating different methods of collecting the necessary data, it was decided that a combination questionnaire—pupil reporting type of procedure would serve the purpose most efficiently.

All phases of number usage were discussed and finally a report form containing seventeen items was adopted. The grade teachers and investigator then presented in very simple language the proposition to the pupils concerned, as follows:

Each pupil was to use the reporting form, as a place on which to record the number of times each day he used any phase of arithmetic. It was explained very carefully and often, that *school* work of an arithmetical nature did not count at all or at any time. Every day the teacher, and as often as possible, the investigator, checked on the data turned in on the

1 Noon, P. G., "The Child's Use of Numbers," Journal of Educational Psychology, 10: 462-467, Nov., 1919.

2 Smith, Nila B., "Uses of Arithmetic in the Out-of-School Life of First Grade Children," Elementary School Journal, 24: 621-661, April, 1924.

3 Ray, Elizabeth, "Arithmetic Readiness in the Kindergarten and Primary Grades," Boston University School of Education, Master's Thesis, 1938.

4 Rogers, Gertrude, "To Provide Aid and a Possible Method for Determining the Problem Units in Arithmetic or the Simple Situations That Connect Sufficiently with Child Experiences to Indicate Their Acceptable Usage," Boston University School of Education, Master's Thesis, 16: 177-181, January, 1937.

5 Wilson, Dorothy W., "Teaching Denominate Numbers and Measures," Educational Method, 1939.

6 Ellsworth, E. E., "What Arithmetic Do Children Use in Their Out-of-School Life?", Master's Thesis, Boston University, 1939.

form, thus cutting down somewhat, at least, unreliable or erroneous information.

At the conclusion of the time allowed (ranging from one to three weeks) all reports were collected, and the tabulation was begun. First, the figures of each individual report sheet were added and totalled. Then all the figures of each class were added

TABLE I. *Showing the seventeen items reported on, the total frequency of each item, and the percentage that each item is of the total.*

		Frequency	*Percentage*
1.	Telling time	14461	27.201
2.	Using U. S. money	8262	15.541
3.	Counting	7196	13.536
4.	Reading numbers	6988	13.144
5.	Writing numbers	4454	8.378
6.	Roman numerals	4039	7.597
7.	Adding whole numbers	2822	5.308
8.	Measuring length	1528	2.874
9.	Measuring weight	1055	1.984
10.	Subtracting whole numbers	1000	1.881
11.	Multiplying whole numbers	593	1.115
12.	Dividing whole numbers	516	.971
13.	Adding fractions	169	.318
14.	Measuring area	25	.047
15.	Dividing fractions	23	.043
16.	Subtracting fractions	18	.034
17.	Multiplying fractions	14	.026
	Total	53163	99.998

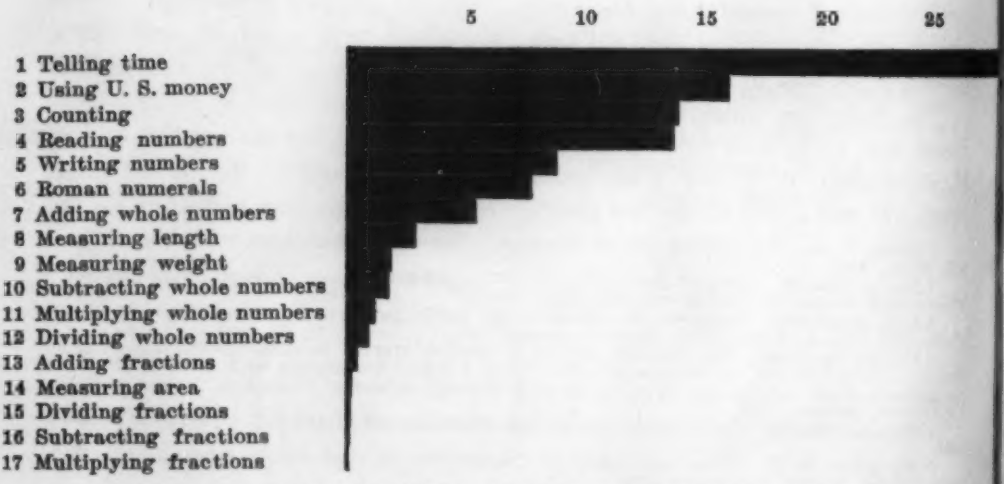

FIGURE 1. *Showing graphically the items and percentage of Table I, as pertaining to all grades.*

and totalled. Following this the totals of all the classes of one grade were compiled. From these totals the grand total of all grades was secured. The next procedure was to determine the percentage of each item as it occurred in each class, each total grade, and for the entire group of all grades. In every case the percentage was carried to at least three decimal places. After this information was secured the next step was to present the data by means of tables and graphs.

All the time that the information was being collected from the pupils, as noted above, the investigator and classroom teachers concerned, checked and questioned items submitted by children. Many notes regarding unusual situations or unexpected occurrences were taken in order to explain any such apparent discrepancies that might appear in the compiled data.

A total of 53,163 items on arithmetic experience were reported by the 390 pupils during this study and Table I shows the frequency of occurrence of each of the 17 items listed, as well as the percentage that each item is of the total (Table I). The percentage of occurrence is shown graphically in Figure 1.

In the recapitulation of data for 62 third grade pupils, only the first nine items listed in Table I were reported, and of these, the first four represented over 66% of the entire frequency.

The final report from 131 fourth grade pupils indicated that only 11 of the 17 items were used, and of these 11, the first four accounted for over 70% of the frequency.

In the fifth grade, 96 pupils reported using all 17 items, although the use of multiplication of fractions (item 17) was reported only four times. In this grade, the first four items account for 56% of the frequency.

The report of 101 sixth grade pupils showed little deviation from the result of all grades as shown in Table I. In this grade, over 75% of the frequency is found in the first four items.

The results of this study seem to justify the following conclusions:

1. Telling time, using United States money, reading numbers, and writing numbers, seem to be in most common usage by children.

2. Roman numerals are used in reading clock faces and in chapter headings. Simple teaching to this extent should be provided as children's interests require.

3. The four fundamental processes of addition, subtraction, multiplication, and division of whole numbers are apparently necessary and 100% efficiency in these should be acquired by pupils.

4. Measuring and measures to a limited degree should be taught as need arises. There are 1,528 cases of measuring length, 1,055 cases of measuring weight, and 25 cases of finding simple area.

5. The use of fractions seems to be limited and largely confined to those children who are interested in the practical arts.

THE SEQUENCE OF PROCESSES AFFECTS THE PUPIL'S INTERPRETATION OF VERBAL PROBLEMS IN ARITHMETIC

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This article refers to a series of studies on the relation of sequence of processes in problems of more than one step. This factor is comparable to (1) form of problem, (2) vocabulary involved, (3) reading ability of pupils, (4) computational ability of pupils and similar factors studied by Clapp, Osburn, Morton, Washburne, Brownell, et al. Such factors are a matter of consequence as long as isolated text problems find a place in our schools.—G. M. W.

OUT of the graduate school of the University of Pittsburgh have come recently several studies which identify a new factor which affects the solution of verbal problems in arithmetic and attempts to determine its effect. These studies are devoted to seeking the answer to three questions: (1) How may the accuracy of the pupil's interpretation of an arithmetic problem be determined without having the finding complicated by the degree of his mastery of the computational skills? (2) What is the relative difficulty of the four fundamental processes in the interpretation of verbal problems? (3) Does the sequence in which the processes occur in multiple-step problems affect the ease or difficulty of their interpretation?

How may interpretation alone be measured?

A fairly satisfactory answer to this question was reached by Ford.[1] His findings were based on the results of giving a test composed of one-step, two-step, three-step and four-step verbal problems to a considerable number of subjects. His directions were in part as follows: "On the answer sheet you will check on the first line the process you would use first, on the second line the process you would use second, on the third line the process you would use third, etc." and an illustrative problem and its treatment is shown below:

"Last week James worked 5 days and received $.60 per day. He had already earned $6.00. He bought a second hand bicycle for $12.60. How many more days will he have to work at the same rate to finish paying for his bicycle?"

	A	S	M	D	
1			x		
2	x				
3		x			
4				x	

Ford found a very high correlation between the results of this test and the results of other measures of problem-solving ability, so it now appears that the technique may justifiably be used to give practice in problem interpretation much in the same way that examples with computations already done

1 Ford, F. C., "The Correlation of Arithmetic Computation and Reading Comprehension with the Conventional and New-type Arithmetic Reasoning Test," Master's Thesis, University of Pittsburgh, 1937.

are used to give focussed practice in multiplication and division of decimals. Since the other questions we have outlined were concerned with interpretation, the technique developed by Ford was used by the investigators who dealt with them.

What is the relative difficulty of the fundamental processes of problems?

Four studies bear on this question. Kornman[2] dealt with one-step problems, Becker[3] and Berglund-Gray[4] with two-step problems, and McIsaac[5] with three-step problems. All used tests containing several examples of each possible arrangement of the processes in problems of the length being investigated. The validity of the three-step problems in representing the sequence desired was checked by submitting more than the number necessary to a jury of experienced teachers and discarding those whose interpretation was ambiguous. The validity of the one-step and two-step problems was relatively easy to assure by the form of statement. The findings of the larger studies were based on the results from nearly 4000 subjects each, distributed to give variety in age, grade level, and geographic location. Per cents of error were computed for each problem and made possible comparison of the processes involved as to relative difficulty with the following conclusions:

1. Division is the most difficult of the fundamental processes and addition is the least difficult in problems of all lengths. In one-step and two-step problems, multiplication appears to be more difficult than subtraction, but in three-step problems subtraction is slightly more difficult than multiplication.

2. Both in two-step and in three-step problems, division is most difficult when it is the first step in the solution, but addition is least difficult when it is the first step. Multiplication is most difficult when it is the last operation of the problem. Subtraction is most difficult when it is the first step of a two-step problem and when it is the second step of a three-step problem.

3. When any process occurs twice in consecutive order in three-step problems, those problems are easier in which that process constitutes the first two steps.

What is the effect of sequence of processes on the interpretation of problems?

There are 12 possible sequences, all of which may occur in life, among two-step problems and 64 possible sequences, 54 of which may have social application among three-step problems. The investigation of two-step problems used six examples of each sequence, that of three-step problems five examples. In spite of careful formulation, it was found impossible to eliminate every other element that might affect difficulty except order of sequence, but the cases in which a

2 Kornman, Marie, made a study not yet published in the schools of Midland, Pennsylvania, 1939.

3 Becker, Fredericka, "Effect of the Processes and Their Order upon the Difficulty of Arithmetic Problems," Master's Thesis, University of Pittsburgh, 1938.

4 Berglund-Gray, Gunborg, "The Effect of Process Sequence on the Interpretation of Two-Step Problems in Arithmetic," Doctor's Thesis, University of Pittsburgh, 1938, also in September, 1940, Journal of Educational Research.

5 McIsaac, John S., "The Effect of Process Sequence on the Interpretation of Three-Step Problems in Arithmetic," Doctor's Thesis, University of Pittsburgh, 1940.

particular example of a sequence had a much higher or lower per cent of error than the rest of its type were relatively few and the ability to draw conclusions from preponderance of forms as well as composite percentages seems to assure valid conclusions.

If sequence is a factor in problem difficulty, problems which present processes in one order should have a

TABLE I

Showing the Effect of Reversal of Sequence for Two-Step Problems

Sequence	*Per Cent of Error*	*Sequence*	*Per Cent of Error*
Add, Subtract	14	Subtract, Add	30
Multiply, Add	29	Add, Multiply	39
Multiply, Subtract	31	Subtract, Multiply	48
Add, Divide	33	Divide, Add	59
Subtract, Divide	47	Divide, Subtract	63
Multiply, Divide	31	Divide, Multiply	64

TABLE II

Showing the Effect of Reversal of Sequence for Three-Step Problems

Sequence	*Per Cent of Error*	*Sequence*	*Per Cent of Error*
Add, Subtract, Add	33	Subtract, Add, Subtract	57
Subtract, Subtract, Add	30	Add, Subtract, Subtract	56
Multiply, Add, Multiply	48	Add, Multiply, Add	57
Multiply, Multiply, Add	20	Add, Multiply, Multiply	66
Add, Divide, Add	57	Divide, Add, Divide	83
Divide, Divide, Add	47	Add, Divide, Divide	65
Multiply, Subtract, Subtract	65	Subtract, Subtract, Multiply	82
Multiply, Multiply, Subtract	47	Subtract, Multiply, Multiply	62
Subtract, Multiply, Subtract	54	Multiply, Subtract, Multiply	68
Subtract, Subtract, Divide	49	Divide, Subtract, Subtract	87
Divide, Divide, Subtract	60	Subtract, Divide, Divide	80
Subtract, Divide, Subtract	77	Divide, Subtract, Divide	85
Multiply, Multiply, Divide	53	Divide, Multiply, Multiply	83
Multiply, Divide, Multiply	69	Divide, Multiply, Divide	73
Multiply, Divide, Divide	61	Divide, Divide, Multiply	76
Add, Subtract, Multiply	42	Multiply, Subtract, Add	62
Add, Multiply, Subtract	56	Subtract, Multiply, Add	62
Multiply, Add, Subtract	44	Subtract, Add, Multiply	61
Add, Subtract, Divide	30	Divide, Subtract, Add	80
Subtract, Add, Divide	55	Divide, Add, Subtract	73
Add, Divide, Subtract	48	Subtract, Divide, Add	78
Add, Multiply, Divide	46	Divide, Multiply, Add	70
Multiply, Divide, Add	55	Add, Divide, Multiply	62
Multiply, Add, Divide	44	Divide, Add, Multiply	74
Subtract, Multiply, Divide	46	Divide, Multiply, Subtract	77
Multiply, Divide, Subtract	58	Subtract, Divide, Multiply	70
Multiply, Subtract, Divide	46	Divide, Subtract, Multiply	81

higher or lower per cent of error than problems which show the same processes in the reverse order. This was found to be true as Tables I and II show.

Again, if sequence is a factor in problem difficulty, it should be possible to rank the different arrangements of two or three processes in three-step problems in the order of their relative difficulty. The results of this attempt both by rank of forms and by average per cents of error were consistent and are here summarized in Table III.

These studies seem to prove beyond dispute that process sequence is a factor in the interpretation of verbal problems in arithmetic and must be taken into consideration by text-book writers, test makers and committees engaged in the preparation of detailed courses of study.

TABLE III

Showing the Ranking in Difficulty of Each Combination of Processes, The Most Difficult is Given First in Each Set of Four or Six

Add, Subtract, Multiply

1. Multiply, Subtract, Add
2. Subtract, Multiply, Add
3. Subtract, Add, Multiply
4. Add, Multiply, Subtract
5. Add, Subtract, Multiply
6. Multiply, Add, Subtract

Add, Multiply, Divide

1. Divide, Add, Multiply
2. Divide, Multiply, Add
3. Add, Divide, Multiply
4. Multiply, Divide, Add
5. Add, Multiply, Divide
6. Multiply, Add, Divide

Subtract, Divide

1. Divide, Subtract, Subtract
2. Divide, Subtract, Divide
3. Subtract, Divide, Divide
4. Subtract, Divide, Subtract
5. Divide, Divide, Subtract
6. Subtract, Subtract, Divide

Multiply, Divide

1. Divide, Multiply, Multiply
2. Divide, Divide, Multiply
3. Divide, Multiply, Divide
4. Multiply, Divide, Multiply
5. Multiply, Divide, Divide
6. Multiply, Multiply, Divide

Add, Multiply

1. Add, Multiply, Multiply
2. Add, Multiply, Add
3. Multiply, Add, Multiply
4. Multiply, Multiply, Add

Add, Subtract, Divide

1. Divide, Subtract, Add
2. Subtract, Divide, Add
3. Divide, Add, Subtract
4. Subtract, Add, Divide
5. Add, Divide, Subtract
6. Add, Subtract, Divide

Subtract, Multiply, Divide

1. Divide, Subtract, Multiply
2. Divide, Multiply, Subtract
3. Subtract, Divide, Multiply
4. Multiply, Divide, Subtract
5. Subtract, Multiply, Divide
6. Multiply, Subtract, Divide

Subtract, Multiply

1. Subtract, Subtract, Multiply
2. Multiply, Subtract, Multiply
3. Subtract, Multiply, Multiply
4. Multiply, Subtract, Subtract
5. Subtract, Multiply, Subtract
6. Multiply, Multiply, Subtract

Add, Subtract

1. Subtract, Add, Subtract
2. Add, Subtract, Subtract
3. Add, Subtract, Add
4. Subtract, Subtract, Add

(Other variations unreal)

Add, Divide

1. Divide, Add, Divide
2. Add, Divide, Divide
3. Add, Divide, Add
4. Divide, Divide, Add

THE TEACHING OF APPROXIMATE COMPUTATION IN ELEMENTARY GRADES

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Approximations, or approximate measures, or approximate computations, are vague terms to most teachers, high school or elementary. Here is an article dealing with this subject, which is simple and direct, and which gives the rules which are applicable. This article is for careful study rather than rapid reading.—G. M. W.

IF arithmetic is taught realistically it should correspond to actual life usages. Too often such usages are ignored with the result that elementary school learnings have to be unlearned and relearned. Such waste is not at all necessary provided teachers will familiarize themselves with the facts of mathematical usage and prepare pupils for these realities.

The entire field of measurement constitutes an area of hazy and inaccurate teaching. Measurements should not be used to provide practice in computation but in a way to give knowledge of how such measurements are actually handled in life. The elementary school pupil can be taught that all measurements are approximate and that the degree of accuracy depends on the size of the unit of measurement and on the use which is to be made of the measurement. He can learn by experience that if he is measuring a length with a ruler graduated in inches he will get a result *to the nearest inch* whereas if the ruler is graduated to sixteenths, he can get a result *to the nearest sixteenth of an inch.*

Then he should learn when it is important to use small units for measurement and when large units are sufficiently accurate. For example, it is accurate enough for all practical purposes to express the distance from the earth to the sun to the nearest million miles. The federal debt has become so large that the nearest billion is near enough for the comprehension of the average person whereas a man's check stubs must be kept to the penny if he is to have his account agree with the bank statement. For practical purposes a farmer may measure a field to the nearest rod but a scientist may have an important experiment go wrong if he makes an error of a tenth of an inch.

It is not at all difficult to teach elementary approximate computation in the upper elementary grades. In fact it is much easier to teach the fundamental facts of this subject at this time than it is to change the computational habits and concepts of graduate students who have never been given the proper knowledge and practice of the real life usage of measurements.

Pupils should be shown that they can measure to the *nearest* foot, the nearest 0.1 foot, the *nearest* 0.01 foot but that they can never measure any length exactly. The pupils should be told that no one in the whole history

of the world has ever made an exactly accurate measurement of any length. The same is true of measurements representing time, weight, volume, area, temperature, latitude and longitude, and the like. The most accurate measurements ever made do not have more than eight significant figures.

Elementary school pupils should be taught the meaning of the term *significant figures.* If a distance has been measured so accurately that it is known to be nearer 687.4 ft. than it is to either 687.3 ft. or 687.5 ft., then each of the first three figures of the measurement 687.4 ft. is correct and the error in the fourth figure is not more than 0.05 ft. or not more than one-half of the *unit of measurement* used — 0.1 ft. Since each figure of the measurement has a definite meaning or significance, the measurement has four *significant figures. To have all its figures significant the error in the last figure of the measurement must not be greater than one-half of the unit of measurement used,* or in other words the last figure of the measurement must be a *nearest* figure as shown above. If the measurement 687.4 ft. has four significant figures, its value must be between 687.35 ft. and 687.45 ft. If the measurement 6.83 in. has three significant figures it must be between 6.825 in. and 6.835 in.

Zeros that are the result of correct measurement are significant. That is, if a distance is measured and found to be 2000 ft. to the nearest foot, the three zeros are significant. If a distance of 697 ft. is called 700 ft. as an approximation, then the first zero is significant, but the second zero is not significant. Similarly, a number like 6000 ft. may have one, two, three or four significant figures according to the accuracy of measurement. *Zeros are not significant when they are used simply to locate the decimal point in a rounded number, as in 8000 mi. Likewise, zeros used before some other digit in a decimal fraction to give place value are not significant;* for example, the zeros in 0.00036 in. are not significant. The two uses of zero are likely to cause a certain amount of confusion, but entirely too much emphasis is placed on this difficulty.

In a set of numbers one can usually tell when the zeros are significant. If the person making the measurements below was familiar with approximate

430.0 ft.
487.3 "
900.0 "
838.4 "

computation, it may be assumed that the zeros are significant. Like people, zeros may be judged by the company they keep. If one sees such measurements as 6,000,000,000,000 miles, or 4,000 miles, or 186,000 miles, one may usually assume that these are rounded numbers, and that the zeros are not significant.

Pupils who secure their own data through measuring will know which zeros are significant; *no author should ever give a rounded number in a problem without telling* the number of significant figures. Example: The speed of light correct to three figures is 186,000 miles per second. How long will it take light to go 7927 miles? Or the speed of light is

186,300 miles per second (4 Significant Figures) etc. If this is done, zeros will cause no trouble.

To find how many significant figures there are in a measurement when decimal measures are not used, express the measurement in terms of the smallest unit of measurement used. Thus, $46°52' = 2812'$ (4 Significant Figures), 43 ft. 4 3/8 in. =)416 3/8 (4 Significant Figures), 24 lb. 1 oz. = 395 oz. (3 Significant Figures).

Figures that are not significant, with the exception of zeros used to correctly locate the decimal point, should never be used in any example.

Computation frequently produces an answer that contains more figures than are warranted by the original data. In such cases, the answer should be rounded off so that figures that are not significant will not be retained.

The following rules may be used for rounding off figures or digits:

1. *"If a number, given to a certain number of significant digits, is to be rounded off to a stated number of significant digits, the digits that are to be dropped should be replaced by zeros. In the case when the digits that are to be dropped are located to the right of the decimal point, the use of zeros is not necessary."*[1]

2. *If the first of the digits that are to be dropped is 5, 6, 7, 8, or 9, the last figures retained should be increased by 1.*

All elementary texts teach pupils how to round numbers, but they do not teach them *when* to round numbers or *why* the answers to certain examples must be rounded.

A	B	C
16.8 ft.		
7.5 "	32.60 ft.	3 4/16 in.
12.0 "	40.00 "	4 3/16 "
3.7 "	18.69 "	5 1/16 "
10.0 "	2.07 "	7 0/16 "
50.0 "	93.36 "	19 8/16 "

In a set of measurements like those shown in A, each measurement should be given to the *same unit;* in this case the *tenth of a foot* is considered to be the unit of measurement since each measurement is made to the nearest *tenth of a foot.* In set A, the zeros in 12.0 ft. and 10.0 ft. are significant. In the same way, in set B, each measurement is recorded correct to the nearest hundredth, the unit in this case being the *hundredth of a foot.* In set B, all the zeros in 40.00 are significant. In set C, the unit of measurement = 1/16 in. is clearly indicated. The 3 4/16 in. in C should not be reduced to 3 1/4 in. and the answer 19 8/16 in. should not be reduced to 19 1/2 in. The answer given is correct to the nearest 1/16 in.; the second answer would lead any expert to believe that the result was correct only to the nearest 1/2 in. The 0/16 in. is unusual but is *necessary* to show that the same unit has been used for each measurement.

The last figure of each measurement in B is a nearest figure and may be slightly more or slightly less than the real value. Because of this there will be an error in the last figure of the answer. The last figure will not always be significant; however, in practical work it appears better to *retain the full answer 93.36 ft.* than to use the rule sometimes given: "Round off

1 A. Bakst, "Approximate Computation," the Twelfth Yearbook of the National Council of Teachers of Mathematics," Bureau of Publications, Teachers College, Columbia University, New York, 1937, pp. 40-41, also p. 275.

the last figure of the answer." This rule would leave the answer 93.4 ft. For practical work in subtraction it is better to retain the full answer as shown in D.

D	E
	376. ft.
	24.183 "
87.64 ft.	8.6 "
28.37 "	1.237 "
59.37 "	?

There is no accurate answer to E. Examples like this should never be given in any textbook or test. In any example in addition and subtraction every measurement should be made to the same unit.

If the measurements are correctly expressed there are no special rules for adding and subtracting approximate numbers in ordinary computation. *Many elementary textbooks instruct pupils to obtain answers correct to one, two, or three decimal places.* Such instructions are doubtless responsible for the fallacy that accuracy of the answer is determined by the number of decimal places.

The accuracy of a computed result or measurement has no relation to the number of decimal places in it. That the accuracy of measurement is not a function of the location of the decimal point may be seen from the following: 3.5 mm. = 0.0000035 km. It is seen that 0.0000035 km. is the two-figure measurement 3.5 mm. changed to kilometers and that both measurements have two significant figures. The position of the decimal point depends upon the denomination used.

The best criterion for accuracy in ordinary computation in elementary and high schools is the number of significant figures. As 3.5 mm. and 0.0000035 km. each have two significant figures, they are of the same degree of accuracy. A number having three significant figures, or three-figure accuracy, is more accurate than a number having two significant figures or two-figure accuracy. A number having four significant figures, or four-figure accuracy, is more accurate than a number having three significant figures, or three-figure accuracy.

Many teachers and pupils have a fondness for long answers but in practical work there is little relative value to any figure beyond the fourth. Pupils will not appreciate approximate computation if they do not get this concept.

After pupils have learned to measure to the *nearest unit,* have learned the meaning of significant figures and can round numbers correctly and recognize the relative unimportance of the last figures of a long number, they are ready for the four simple rules that follow.

When two approximate numbers are to be multiplied, the following rules should be used:

1. *If two approximate numbers have the same number of significant figures, multiply the numbers and round off the product to the same number of figures as there are in each factor.* The last figure of the answer will not always be significant, but this rule is satisfactory for all elementary work and is usually followed in scientific work.

2. *If two approximate numbers are such that one of them has more significant figures than the other, first round off the more accurate approximate number so that it contains one*

more significant figure than the less accurate approximate number. Then multiply the numbers and round off the product to the same number of figures as there are in the less accurate factor. A product can never have more significant figures than there are in the least accurate of the factors used in the computation. In many cases it may have one less significant figure, but for elementary work the rules given above should be used.

3. *If the two approximate numbers have the same number of significant figures, carry the quotient out to one more figure than is contained in each of the given numbers. Then round off the quotient so that it contains the same number of figures as there are in each of the given numbers.*

4. *If the dividend and divisor are such that one of them has more significant figures than the other, first round off the more accurate number so that it contains one more significant figure than the less accurate number. Then divide and carry the quotient to one more figure than is contained in the less accurate of the given numbers. Finally round off the quotient to the same number of figures as are found in the less accurate number.*

When the above rules for dividing approximate numbers are used, the last figure of the quotient will not always be significant but the rules should be used for all elementary work.

In the actual work of dividing two approximate numbers, it is often necessary to annex zeros to the dividend in order to secure the number of figures in the quotient warranted by the original data. *It is never permissible to annex zeros in addition or subtraction since this would be an attempt to change the accuracy of the original data.*

When used in multiplication and division, the rules of approximate computation should be applied *only to approximate factors.* If a formula contains exact numbers as well as approximate numbers, the rules of approximate computation should not be used with the exact numbers. When a formula contains approximate numbers such as π or the tangent of an angle, the values used for π or the tangent should be rounded off to one more significant figure than is contained in the least accurate of the other approximate numbers in the formula. This agrees with rules 1 to 4.

Approximate computation should be taught in the elementary school because of the following reasons:

1. It is the only "real life" computation for practical problems.

2. It gives pupils a definite criterion for rounding answers in multiplication.

3. It gives pupils a criterion for telling at a glance how far to carry out any problem in division.

4. It gives pupils a criterion for determining the number of figures to retain when using such numbers as 3.14159, 0.785398 or 0.3183098, metric conversion factors — 1 Km. = 0.6214 mi., approximate values such as 1.25 cu. ft. = 1.00 bu., specific gravities—lead=11.34, tangents, and the like.

5. It gives pupils a criterion for telling how far to carry out any square root example.

6. It gives pupils a criterion for telling how far to carry out the answer

to an equation, and how to check this answer.

7. It gives the pupils a criterion for telling how far to carry out the answer to any written problem.

8. It enables pupils to use our old measuring units along with decimal factors and retain the proper number of significant figures.

9. It prepares pupils for such approximate methods of computation as the use of logarithms, the slide rule, graphic solutions, square root tables, compound interest tables and the like.

10. It eliminates ragged decimals in addition and subtraction.

11. It enables pupils to tell when they may annex zeros — only in division and roots — and how many zeros they may annex.

12. It gives pupils a criterion for working with fractional measurements. They will never make the mistake of assuming that 4 1/2 in. always equals 4 32/64 in., and they will know that if they reduce 4 32/64 in. to 4 1/2 in., they reduce the indicated accuracy of the measurement from three significant figures to one significant figure.

Approximate computation is necessary in many phases of high school mathematics, such as square root, radicals, quadratic equations, numerical trigonometry, all graphic work, all practical problems based on measuring, with logarithms, and with the slide rule. It is also necessary in almost all work in science.

There is no reason why a proper foundation for this work cannot be laid in the elementary grades when data of measurement are being considered.

TEACHING ARITHMETIC THROUGH ACTUAL PROBLEM-SOLVING SITUATIONS

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This brief article describing progress in newer and more functional viewpoints in problem phases of arithmetic is most encouraging. .The work is in the hands of the teachers. Obviously teachers can change their ways to match the newer demands being made upon our schools.—G. M. W.

ABOUT three years ago teachers in Houston, Texas, began work on a revision of the arithmetic courses for elementary schools and junior high schools. The first step in this work was the compilation of a bibliography to show some of the newer trends in methods of teaching arithmetic. After much reading and discussion it was decided to set up a chart to show progression from grade to grade with respect to: (a) types of experiences found at each grade level which demand the use of numbers; (b) information and skills in number manipulation needed for coping with the experiences listed at each level; and (c) growth from grade to grade in problem-solving techniques. The main purpose of these charts is to indicate drill expectations, as a basis for problem solving.

In Houston the work in both elementary schools and junior high schools is organized in large integrating units and in carrying out the activities suggested in these units pupils use various types of subject matter, including arithmetic, as needed. Therefore, in selecting the types of experiences to be stressed at each grade level, teachers considered not only those practical out-of-school activities in which their pupils use numbers but also those activities suggested in the units at each grade level. For example, when pupils in the first year of junior high school are reading to get information about "The Earth and Its People," they have need to employ large numbers when reading population figures; when considering density of population; when comparing our ways of getting food, clothing, and shelter with the ways by which people who live in different physical environments satisfy their needs. Consequently, the arithmetic course provides the necessary information and drill materials to enable them to handle such numbers with ease. Our course of study plans, Exhibit C, Low Sixth Grade, shows that arithmetic is closely associated with the social studies program, —populations, occupations, products, transportation. There is much use for graphs.

When the course of study plans or charts were finally agreed upon by all teachers from the kindergarten through the ninth grade, they were accepted as the basis upon which to build the new arithmetic program. The next step in developing this program consisted in asking teachers at each grade level to submit actual problems they considered essential to their pupils. All of the teachers' suggestions were

turned over to small committees from each grade who were paid by the Board of Education to spend several weeks in their vacation period organizing them in usable form. Teachers had not progressed far in the development of these newer arithmetic courses when they found that commercial drill books on the market failed to meet their needs; therefore, we have been obliged to construct our own work books—a task which has taken a much longer time than we had expected it to take.

At the present time teachers in the senior high school are engaged in developing two types of arithmetic courses for pupils who do not care to take formal algebra and geometry courses. For pupils who expect to enter business or secretarial work, our teachers are developing units in *Commercial Arithmetic;* for pupils who expect to go into industry they are developing units in *Industrial Arithmetic.* These courses are in process of being mimeographed.

In all of our arithmetic courses, from elementary grades through senior high school, we are trying to base required practice in number computations on actual problems that really matter to the pupils. For example, we are attempting to rule out all examples based on "what Jane did" or "what Jack bought." In every grade we are trying to say to each pupil, "Here is a situation in which *you* are likely to find *yourself.* What do you need to know in order to understand this situation better? What number calculations do you have to make in order to find a solution to your problem?"

In fact, the most difficult part of our curriculum revision work has been to get ourselves to break away from the usual traditional examples and face facts in selecting problems. Over and over we have to ask ourselves, "Are we sure that these particular pupils really need to solve this particular problem? Or, have we been tempted to slip this problem in merely because we are seeking some way in which to get additional practice on division of mixed numbers?" Gradually, however, all of our teachers are coming to be quite critical of the problems suggested, and frequently such a criticism as this comes from the classroom: "I believe we ought to revise our last workbook immediately for there are several problems in it that do not really matter to my pupils." At present, however, we are still in the midst of getting our first draft of courses ready for use in the classroom; but we know that just as soon as we complete these first courses, we shall be ready to begin revising and improving them.

WHAT RESEARCH INDICATES AS A PROFITABLE PROGRAM OF WORK IN DENOMINATE NUMBERS AND MEASURES

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This research article on measures was presented as a paper before the American Educational Research Association at Cleveland in February, 1939. It was held out of the annual volume of the Association in order that it might appear in this special number of EDUCATION *which had already been promised. It is here appropriate to suggest that some of the arithmetic time which we have been wasting on encyclopaediac knowledge of denominate numbers and measures, can now be spent on developing more functional problem units.*—G. M. W.

THE credit for suggesting this study on denominate numbers and measures goes to Dr. Worth J. Osburn. In the chapter on denominate numbers in his *Corrective Arithmetic,* Vol. II, 1929, are statements such as the following:

"The child who masters them (denominate numbers) must memorize a large number of facts, and there is little chance of organization in those facts." Osburn then gives thirty-three table facts that must be committed.

"In addition to these thirty-three facts there are thirty-eight others which have a good claim to a place in our course of study." Here follows such isolated items as the number of cubic inches in a bushel, the weight of a bushel of corn, the weight of a bale of cotton, the length of a city block, the number of square feet in an acre, etc.

"There are no connecting links . . . Most of the facts must be memorized by rote."

"Such are the difficulties of the situation. What is the remedy? . . . The remedy lies in the metric system."

The gyrations of the metric system in French history did not tend to allay our suspicions that Dr. Osburn may have made a mistake in recommending the metric system as the solution of our troubles in teaching weights and measures in our schools. Accordingly, our studies of weights and measures went forward, and gradually broadened to include problems other than the possibility of a metric solution.

During the summer of 1929 a summer session class sent a questionnaire to typical representatives of various lines of industry throughout the United States. Among the 92 industries making returns were such firms as the Atlantic Refining Company, Swift and Company, Bethlehem Steel Company, Aluminum Company of America; in fact, the larger and many smaller companies of all lines of industry throughout the country. This particular inquiry sought a few simple details. One of these related to foreign shipments and the necessity of utilizing the metric system. To our surprise, one large company after another replied that they shipped to all parts of the world, that they paid no attention to the metric system, and that they depended entirely upon the excellence of their products to maintain their sales in foreign countries.

This first large field study was a challenge in many respects. It indi-

cated a need for weights and measures, even in the larger industries much easier and simpler than the scheme being taught in the schools.

The following year was taken as a sabbatical and utilized for the study of measures in industries throughout the United States and also in certain countries of Europe, — in England, Belgium, France, and Germany. On the Continent, particular attention was given to the metric system, and such conclusions as the following were tentatively arrived at:

(1) The customary measures continue, even after a century of compulsion, to form the basis for much of the thinking of the people.

(2) The introduction of a new system, such as the metric, does not mean the discontinuance of the old system. It merely means that there are two systems instead of one.

(3) Any metric unit that has been readily accepted by a people is a close approximation to a customary unit. (For example, the meter and the yard. In the case of the pound, there is no close metric approximation in a unit; the result is that the half-kilo has become the common unit for weight in metric countries; and the half-kilo is generally called the pound by the common people.)

(4) Metric units that do not closely approximate customary units have, in general, been accepted slowly and unwillingly, if at all.

(5) Useful metric units, such as the meter or the half-kilo, are halved and quartered exactly as the customary units in this country. Thus, in Paris, one-half pound of butter becomes a half of a half-kilo.

(6) Decimalization is used in statistics and in close-fit measurement, but is not more used with metric units than with customary units.

The early studies on metric usage leading to the rejection of the conclusion that "the remedy lies in the metric system," have been continued. A student working at the doctorate level has made an extensive study in metric South America, the results of which should be available within another year.

Study of Customary Measures. The first large study of 1929, which secured returns from 92 industries throughout the country, laid a basis for questioning another practice in the schools and recommended by Osburn; namely, reduction, ascending and descending. Says Osburn: "In the teaching of denominate numbers much effort will be necessary in connection with reduction. . . . We have reduction both ascending and descending."

The question of how much reduction is needed was joined with the further question as to the percentage of people using measures in industry, and was pursued through several studies. Traniello,[1] 1930, studied the use of measures in a department store and four manufacturing industries in Porto Rico. He concluded in general that any commodity is likely to be described and sold in a single unit; that the effort in life is toward understanding the commodity rather than the measures which might be used; and that in general, reductions do not occur except in the Cost Accounting Department.

Louth[2] studied the use of measures in five highly specialized industries in Providence, Rhode Island,—a silver-

1 Traniello, Angelo, "Measurement in Business," Master's thesis, Boston University, 1930.
2 Louth, Mary de S., "Units of Measure in Industry," Master's thesis, Boston University, 1931.

smith industry, a textile finishing industry, an industrial piping industry, a jewelry manufacturing industry, and a winding machine industry. Miss Louth found that reductions by the rank and file of industrial workers, did not take place. Any reductions taking place were figured in the Cost Accounting Department. She found also that it is seldom that more than a single unit is needed to describe a commodity. For example, of 1344 measures used in a checking of the Universal Winding Company, there was one unit of measure only needed in 1120 instances. The 224 other instances called for two units as follows: foot and inch in 162 cases; degree and inch in 14 cases; yard and minute in 48 cases. The use of a single unit is illustrated by the buying of lead by the pound,—not pound and ounces. Lead is bought by the pound, regardless of the amount, even though it may be hundreds of tons. The use of two units is illustrated by the buying of paper, which is described both as to number of sheets and the weight. In the case of paper it may also be described by the size of the sheet.

A typical table from Louth is the following summary table (Table I) showing the number of employees in the five industries and their distribution among what she has called First, Second, and Third classes in the use of measures. The First Class, amounting to 11%, are those who use measures in an expert manner. The Second Class, amounting to 12%, need a reading knowledge of measures. The Third Class, making up 77% of the total, have no use for measures. They are people who do the common labor about a plant,—loading and unloading, etc.

TABLE I

"Analysis of Number in Industries Studied Who Need to Understand Units of Measurement

	No. Employed	*1st Class*	*2nd Class*	*3rd Class*
Gorham Manufacturing Co.	770	83	64	623
U. S. Finishing Co.	437	37	29	371
Grinnell Co. Inc.	365	35	44	286
B. A. Ballou and Co. Inc.	132	21	13	98
Universal Winding Co.	957	111	175	671
Total	2661	287	325	2049
Percentage		11%	12%	77%

Sala[3] studied measures in important industries in New Britain, Conn., supporting at every point the conclusions reached by Traniello and Louth, namely, that tables are little needed by workers in industry and that reductions are performed only by specialists.

At this point, a new line of study opened up and helped to answer the

3 Sala, Vincent, "Denominate Numbers Used in Four Factories of New Britain, Conn.", Master's thesis, Boston University, 1931.

question: "What measures do people know and why?" or, "Under what circumstances do people know a measure?" Following a number of smaller studies, Dorothy W. Wilson[4] developed a plan of checking on the common knowledge of measures of both children and adults. Children were selected from the third through the twelfth grade, a total of 1,097 grade children, 647 junior high school children, and 314 senior high school children. There were 761 adults drawn from four sections of the country, namely: New England, the Middle West, the South, and the Pacific Coast region. The results of this study were even more surprising. The data indicated clearly that the measures which people know are determined by experience. Measures learned in school and not used tend to be forgotten. Most people know only a few simple measures.

These conclusions may be illustrated by taking the case of two measures. Gasoline is an illustration of a measure learned early in life and known perfectly by about 99% of the people from the fifth grade on through adulthood. Over 90% of third grade children know that gasoline is sold by the gallon.

By contrast, the measure used in selling cotton lint is known by almost no third grade child, by only a little over 10% of seventh grade children and, in general, by less than 50% of the adult population (university grade.) However, the percentage of people knowing the commodity clearly varies with experience. The unit for sale of cotton lint is more generally known, for instance, in the cotton section of the South than it is in the Middle West, or in New England. On the other hand, the unit in which wool is sold is much better known in the Middle West than it is in New England, due to the fact no doubt that few sheep are raised in New England, while people on the farm in the Middle West often have a few sheep. Among the conclusions justified by the Dorothy W. Wilson study are the following:

"(1) Elementary school children, even as far down as the third grade, do have some knowledge of the measures which are used in buying commodities commonly used in the family, such as bread, milk, eggs, sugar, and gasoline.

"(2) As children mature, they develop in knowledge of common measures. All told, experience seems to be the most important factor. If a fact or a practice, such as the buying of gasoline, is so common as to come within the experience of all children at an early age, then the fact is known regardless of any teaching done by the schools.

Nor do children remember tabled facts that are not used.

"(3) One cannot escape the conclusion that maturation and experience are the chief factors accounting for knowledge of measures. It would appear that the facts of denominate numbers and measures are in the nature of encyclopediac information to be looked up when needed and not taught with the expectation that, if memorized, the facts will be remembered."

"What then should be the program of the schools? Evidently, not the metric system, for the customary measures which have survived through the centuries, are, all told, better adapted to trade and industry than

4 Wilson, Dorothy W., "What Measures Do People Know and Why?", Master's thesis, Boston University, 1936.

are the metric measures. Evidently the right procedure is to extend the experience of the child. Adults do not go about using measures promiscuously; they use them only when the need arises. They buy and sell in units; they occasionally measure something or estimate in units. If our teaching were to follow a similar plan, it would mean that the child would be led into a knowledge of commodities and then the units would be applied to those commodities. There is apparently no advantage in going beyond experience; there is no point in teaching the average Northern child the number of pounds in a bale of cotton. He will forget it promptly and is not to be blamed for so doing. On the other hand, children who live with cotton, plant it, cultivate it, pick it, ride the load of seed cotton to the gin, and ride back again with a bale of cotton have the experience basis for this knowledge, and so it remains theirs without any effort on their part.

"The other thing that the schools may do is to lead the child to develop clear objective concepts of simple measuring units. The child should be able to estimate the length and width of a room; he should be able to pace with a high degree of accuracy a given distance. The viewpoint here is somewhat that of the boy scout, learning to do in a practical way.

"Beyond the development of experience and the building of clear concepts for practical use, there is little to do. The committing of tables is unprofitable. Reductions are unprofitable. Addition, subtraction, multiplication, and division of compound numbers should be omitted from course requirements and from all tests.

"Many textbooks develop manipulation in the measures and denominate numbers through hundreds of pages. The process is meaningless to the child at the time; the results are promptly forgotten. The time so spent has been wasted or, at least, very unprofitably employed."[5]

In recommending the omission of a difficult and profitless drill program in denominate numbers and measures, I do not forget that there is a small practical program (as indicated), and also a possibility of worthwhile appreciation units. But these will be reasonable and sensible in comparison with the old program of useless drill. Much time will be left for satisfactory mastery (at upper grade levels) of the useful fundamentals of arithmetic and for other curricular objectives, the need for which are strongly indicated by this changing society of ours—local, national, international.

5 The last four paragraphs are quoted in part from the conclusion of Chapter XVIII, "Teaching the New Arithmetic," by Wilson, Stone, and Dalrymple, McGraw-Hill Book Company, 1939.

BRIEF BIBLIOGRAPHY ON ARITHMETIC PROBLEM UNITS

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***These few references give the interested reader an opportunity of realizing that functional problem units in arithmetic are not a new idea and that they are supported by a considerable bibliography.*—G. M. W.**

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TWELFTH ANNUAL SCHOOL ADMINISTRATORS' CONFERENCE

GEORGE PEABODY COLLEGE FOR TEACHERS

NASHVILLE, TENNESSEE

The Twelfth Annual School Administrators' Conference at Peabody College will consist of a series of *Forums.* It will be held on Thursday, Friday, and Saturday, June 19, 20, and 21.

The theme for these forum discussions will be "Educational Leadership in the Present Emergency." At the five forum sessions these problems will be discussed:

Indications in the Present Emergency of a Parallel System of Schools Provided by the Federal Government

Vocational and Technical Education in the Present Emergency

Maintaining Adequate and Efficient Educational Personnel in the Present Emergency

Financing Schools in the Present Emergency

After the Emergency — What?

City and County superintendents, high-school and elementary-school principals, supervisors of instruction, officials in state departments of education, and other types of school executives and all interested teachers in elementary and secondary schools are invited to attend this Conference and participate in these forum discussions. No fee is charged for attending or participating in the Conference.

For further information write Dr. Dennis H. Cooke or Dr. Ray L. Hamon, Peabody College.

EDITORIAL

THE SOCIAL SCIENCE TEXTBOOK INVESTIGATION

CARL G. MILLER

WE all have been reading with interest, if not with approval, about the investigation of textbooks in history and government by the National Association of Manufacturers. It is an extremely interesting topic to discuss because no matter which side one takes he is liable to be "shot at" by an irate "soldier" from the other side of the "trenches." It is also an inviting topic to follow because it offers a good opportunity to observe how well educators and educated manufacturers, both of whom should know how to argue, can carry on a debate in a really intelligent way.

It appears that the manufacturers are interested in the teaching of civics and history because they fear some social science teachers are undermining representative democratic government. They don't want this replaced by socialism or communism because such forms of government will ruin their business. A few, down deep in their hearts, might favor fascism, but at this stage why not, for diplomatic reasons, give them the benefit of the doubt?

Now, have the manufacturers any cause whatsoever to be suspicious of the social science teachers and authors? It seems reasonable to say that an absolute "no" to this would indicate simple-mindedness. If there are propagandists in this country trying to do deviltry—and nearly every one says there are — are these propagandists so ignorant that they would ignore the schools? And if they should decide to play their tricks in the schools, in which department would they naturally try to operate?

Next, what about social science teachers themselves? Well, in the first place they are teachers, and teachers as a group are idealistic—sometimes hopelessly so. Some social science teachers, not content with the way representative democracy is working, would have a tendency to find something more satisfactory and begin to emphasize it, or preach it. Furthermore, as some of the manufacturers have pointed out, some social science teachers have had an extremely limited life experience. Too many have gone through school only to teach school, and over them any one with common sense can exclaim: "What have we here?" They are persons who have never had their political theories counterbalanced with practical living. Of course, among all the social science teachers there is a large group—we'll say the largest, to be agreeable—who know just what they are teaching and are really doing a good job of fair-minded instruction in history that interprets the present and in government that helps to maintain American ideals in democracy.

Another characteristic of human nature that works against social science teachers is the fact that the radicals are the aggressive ones. For the press, the social science teacher, or the social science student, who believes in

American democracy and conforms to it is not news; it is the one who doesn't that is news. Thus, accounts of subversive teaching leads some unwise reasoners to conclude that what is true of some is true of all—a fallacy of which most persons are guilty every day in the week.

A few fair conclusions on this controversy, it seems, should be stated. The principal one is to decry blanket charges and blanket denials. The manufacturers have no business to say that all science instruction is rotten with subversive teaching, and the social science teachers, with their administrator defenders, have no business saying that they are as innocent as lambs. It behooves every administrator to look into his social science department every now and then to see that everything is all right there. As for the textbooks, they probably can well be examined and if they have danger spots, the spots might be labeled with caution signs for innocent young teachers and reddish old ones.

SUMMER INSTITUTE FOR SOCIAL PROGRESS

"Strengthening America at Home and Abroad" is the theme of the Summer Institute for Social Progress which extends a special invitation to teachers to attend. Following the convention of the N. E. A. in Boston, the conference will be held July 5th to 19th on the beautiful country campus of Wellesley College on Lake Waban, Mass.

The foreign policy of the United States and its chief domestic problems will be discussed under leading economists and teachers of political science from both the East and the West. Informal atmosphere. Recreation. For program apply to Dorothy P. Hill, Director, 22 Oakland Place, Buffalo, N. Y.

DEPARTMENT OF BOOK REVIEWS

Mathematics for Today, Book 1, 434 pp.; Book 2, 444 pp. Henry Holt & Co., 1940. **Everyday Mathematics**, 500 pp. Henry Holt & Co., 1940. **Junior Mathematics**, Book 1, 438 pp.; Book 2, 436 pp.; Book 3, 502 pp. Henry Holt & Co., 1940. *Harl R. Douglass* and *Lucien B. Kinney*, authors.

It is not a simple matter to give a summary of these 2754 pages within the limits usually set for a book review. The books represent a definite attempt to put the newer philosophy of arithmetic and other phases of mathematics into profitable forms for use at the junior high school level.

Mathematics for Today contains the essentials of arithmetic for grades seven and eight for schools in which algebra is begun in the ninth grade. "Enrichment" is provided. "Reasons" are developed for procedures given. "Remedial work" in the fundamental is planned. "Problem solving" is taught and checked through the use of problem scales. Literal numbers and the formula are gradually introduced. There are vocabulary check-ups. All this in Book 1, along with systematic work in fractions, decimals, and percentage, approaches to geometry in lines and angles, areas and surfaces.

Book 2 goes further with tables, the formula, and the graph, common geometric figures, symmetry, and proportion. Applications of fractions, demicals, and percentage are provided.

In both books there is much attention to personal problems—personal purchases, household expenses, farm problems, school problems, banking, investments, safety, health, civics, communication, transportation. All this is in line with recommendations of national committees and work of Thorndike, McMurry, et al., but it does not go far enough (see below).

Everyday Mathematics is in direct response to the Joint Commission as reported in the Fifteenth Yearbook of the National Council of Teachers of Mathematics. It develops "socially valuable topics." It utilizes "the more advanced fields of mathematics." It gives attention to "problem" solving and to remedial work in the fundamentals. The book is designed for use in the ninth grade in schools where algebra is not required.

Junior Mathematics is "a three-book series for grades seven, eight, and nine in schools in which formal algebra is begun in the tenth grade." Book 1 in *Junior Mathematics* has the same chapter headings as Book 1 of *Mathematics for Today*. Book 2 of *Junior Mathematics* follows less closely Book 2 of *Mathematics for Today*, adding more of geometry and more of vocational mathematics. Book 3 of *Junior Mathematics* expands in two directions, business arithmetic on the one hand and algebra and geometry on the other hand. There is a chapter dealing with "Diagnostic and Remedial Program."

Obviously, these books by Douglass and Kinney show changes in emphasis and content that are in the right direction. There is more attention to meaning, to useful applications, and to proficiency in the fundamentals.

Notwithstanding many improvements, a progressive viewpoint would recognize many defects or shortcomings in these books. The load is very heavy. It could be lightened by provision for choice in selection of social and business units, and a recognition that much of the work beyond the fundamentals may be looked upon as appreciation opportunities and not as essential drill. This would permit much higher standards in essential drill.

The heavy traditional load can be easily illustrated. Take fractions as an example. Fully 50% of adult usage of frac-

tions is covered by the fraction ½ alone. Fractions in halves, thirds, and fourths cover well over 80% of adult usage. Eighths stand alone as a special case. Twelfths represent another special case. When these two special cases are added to halves, thirds, and fourths, we have fully 95% of adult usage of fractions, and all that is reasonable as drill. However, looking into Book 1 of *Mathematics for Today*, fractions appear with drill expectations far beyond common usage of adults. Such fractions as 36/10, 34/11, 96/99 are to be changed to proper fractions; and 3 11/24, 2 10/11, 2 5/9 are to be changed to improper fractions (p. 53). There are additions of 15ths, halves, 5ths, and 10ths; of 8ths, halves, 12ths, and 16ths; of 7ths and halves; of 8ths and 6ths; of 4ths and 10ths; of 12ths, halves, 4ths, and 5ths; of 4ths, 16ths, 5ths, and 12ths (p. 57, 60, 61). There are multiplications of 3ds by 7ths; of 7ths by 8ths; of 4ths by 21sts (p. 63); of 6ths by 13ths; of 4ths by 9ths (p. 69); of 3ds by 11ths; of 8ths by 7ths; of 11ths by 6ths (p. 177). In division of fractions, a process seldom used in any form, the pupil is asked to divide 15ths by 9ths, 11ths by 7ths, 22nds by 11ths, 7ths by 5ths, 40ths by 16ths (p. 71). The ordinary adult could live for one hundred years and not encounter any such combinations as these on a drill basis except by rare chance. Fractions to be changed to percents include 5/9, 7/12, 9/16, 7/11, 9/13, 15/64 (p. 125, 126), tasks quite beyond any sensible usage, and in a world where so many useful things need to be done.

There are other traditional hand-overs in decimals, in denominate numbers (p. 215, 266), in non-functional problems and problem scales (p. 77-78, 268, 376). There is metric propaganda which follows the original brief for the untried system (1792) and neglects the sane observations of J. Q. Adams (1823) and the extensive field studies of the present century. The testing program defeats itself by time limits and by characterizing as "good" nine correct answers out of twelve. Geometry is presented on a mastery basis instead of the preferable appreciation basis.

Notwithstanding much progress in texts in arithmetic and high school mathematics, there is still much to do. Drill on the useless needs to be greatly reduced. Techniques other than drill need to be recognized.—GUY M. WILSON, Boston University.

Life, Liberty, and Property. By *Alfred Winslow Jones*. J. B. Lippincott Company, Philadelphia, 1941, 397 pages. $3.50.

This study seeks to find the answers to a number of problems which are acutely pressing for solution in our American democracy. What is the attitude of the American public toward the conflict between property rights and personal rights? What are the signs pointing to class cleavage in America and how serious are they? The author has developed a new and effective technique for getting the opinions and intentions of inarticulate America in relation to these two major problems. The city of Akron, Ohio, the center of the American rubber industry, was taken for intensive study. The first part of the book deals with the growth of Akron from a farm area of Connecticut's "Western Reserve" to the rubber manufacturing capital of the world. It is the author's plan to describe in detail the particular scene and then to study the attitudes toward corporate property which have developed in this socio-economic milieu. The technique employed is most unique and challenging. Various groups in Akron's population—the village storekeepers, the farmers, the rubber technicians, the girls in the offices, the teachers, the clergy, the "little business men," the C. I. O. workers, the "red apples" (workers who side with the corporate management,) the W. P. A. workers, the "magnates"—were interviewed and asked to comment on certain "stories" prepared by the author which involved problems of conflicting interests. The major portion of the volume is devoted

to a searching study of these reactions. The work is a realistic study in psychology and sociology. The experiment was carefully planned and efficiently executed. The results are, therefore, highly significant.—WILLIAM P. SEARS, JR., New York University.

Lowell: A Study of Industrial Development. By *Margaret Terrell Parker.* The Macmillan Company, New York. 1940. $2.25.

This is a study of the economic vicissitudes through which the city of Lowell, Massachusetts, has passed during the last one hundred years. In 1936 Lowell completed a century of life as an industrial city. No other American community of industrial origin has been a city for so long a period. For the first eight decades of its growth, Lowell experienced tremendous industrial growth and population increase. The latter years, however, have been years of difficulty, of changing industries, and loss of population. Cotton manufacturing, for years the mainstay of the economic life of Lowell, has ceased to be the city's leading industry. Dr. Parker indicates very objectively the changing character of the economic life of this city which was once "The Spindle City." The study was originally presented in partial fulfillment of the requirements for the degree Doctor of Philosophy to the Faculty of the Division of Physical Sciences of the University of Chicago. — WILLIAM P. SEARS, JR., New York University.

Children of Bondage. By *Allison Davis* and *John Dollard.* American Council on Education, Washington, D. C. 1940. 300 pages. $2.25.

This is a study of personality development of Negro youth in two cities of the Deep South, Natchez and New Orleans. Over two hundred Negro adolescents were carefully studied by a corps of interviewers and from the data gathered, seven case studies were selected as representative. These case studies constitute the core of the present volume. The authors in stressing social class have presented three cases from the lower class, three from the middle class, and one from the upper class. An additional case is presented for the reader to analyze. Both caste and class have been taken into consideration in the case studies, with the authors stressing class at the expense of caste. In the treatment of personality, the authors incline to the Freudian point of view and the reader is some times startled at the importance assigned to the role of the cleanliness habits of early infancy and childhood in the development of character and personality. The authors are hopeful that through an objective study of the environment in which Southern Negroes move and have their being progress toward wholesome character development may be achieved and social justice attained. The volume is a provocative one.—WILLIAM P. SEARS, JR., New York University.

Professional Education for Experienced Teachers. By *K. L. Heaton, W. G. Camp,* and *P. B. Diederich.* The University of Chicago Press, Chicago, Ill. 1940. x + 142 pages. $1.25.

This volume gives a report of the "workshop movement" by three men closely associated with it. The "workshop" was originally promoted by the Progressive Education Association. The first of its kind was held at Ohio State University in 1936. Since that time many graduate schools have experimented with this program. Local school districts near universities have availed themselves of this technique for the in-service training of teachers.

The Commission on Teacher Education of the American Council of Education has recently organized a Workshop Advisory Service to study, promote, and further refine the "workshop" technique. The Commission is more desirous at this stage of the development of the "workshop" to stress further evaluation and improvement rather than increase the number of centers. An experienced "workshop" staff is now available to aid in organizing and planning. This little volume will prove

suggestive to teacher-education institutions and local districts that contemplate availing themselves of this approach to the solution of educational problems.

The authors discuss the essential characteristics of the "workshop" program, its organization and administration, and how to make it effective. Valuable suggestions are given. It is admitted that the "workshop" has "served primarily the needs which are characteristic of the experienced teacher." No attempt has been made to study the possibilities as preservice training technique. There is no question that the in-service teacher who has reached the graduate level and who has some experience in classroom teaching can approach his further education from a problem point of view. The "workshop" affords this opportunity in a more adequate way than seminars as we generally know them, and conferences or discussion groups. As an instrument for more intensive development of the in-service teacher, the "workshop" has unmatched possibilities.

The criticism has been made that many "workshops" are propaganda instruments for Progressive Education (capitals are used advisedly). This volume substantiates that criticism. On page 113 the authors state "workshop participants have almost universally rejected a course of study, outlined in advance, as a method of organizing a school program." Quotations of this kind could be further multiplied. That a "workshop" for graduate students who are experienced teachers begins without a program planned in advance in every detail cannot be denied. To apply the same technique to all learning at all levels, is quite another matter. This volume itself is more than an evaluation of "workshop" technique. It constitutes a bit of propaganda for a philosophy of education being seriously questioned by keen thinking minds and caustic observers. Divorce the "workshop" from the Progressive School of thought to assure its future development.—C. JAARSMA, State Teachers College, Slippery Rock, Penna.

A Guidance to Guidance. By *Charles M. Smith* and *Mary M. Roos*. Prentice-Hall, Inc., New York. 1941. $3.00.

This is a rather elementary introduction to certain phases of guidance as carried on in our schools. The authors make especial reference to the work being done in the schools of New York City. The psychological and sociological bases of personality are superficially treated and much of the book is devoted to anecdotes characteristic of the arm-chair school of philosophy. The section on mental hygiene is very weak. However, the same can be said of the other chapters, too.—WILLIAM P. SEARS, JR.

Growing Up in the Black Belt. By *Charles S. Johnson*. The American Council on Education, Washington, D. C. 1941. 360 pages. $2.25.

This is another volume in the American Youth Commission's series of studies on Negro youth. The staff which conducted this admirable study zealously tried to uncover and analyze the basic processes which determine the social attitudes of Negro youth, particularly with respect to their position as Negroes in different communities. Dr. Johnson has taken the life history documents, the case studies, the individual interviews, and the attitude and psychological tests and has woven the results into a unified statement that is at once both a human interest document and a scientific report. The volume has value for all those interested in education, in social work, and in planning for a truer democracy.—WILLIAM P. SEARS, JR., New York University.